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THE IDE ENGINE.

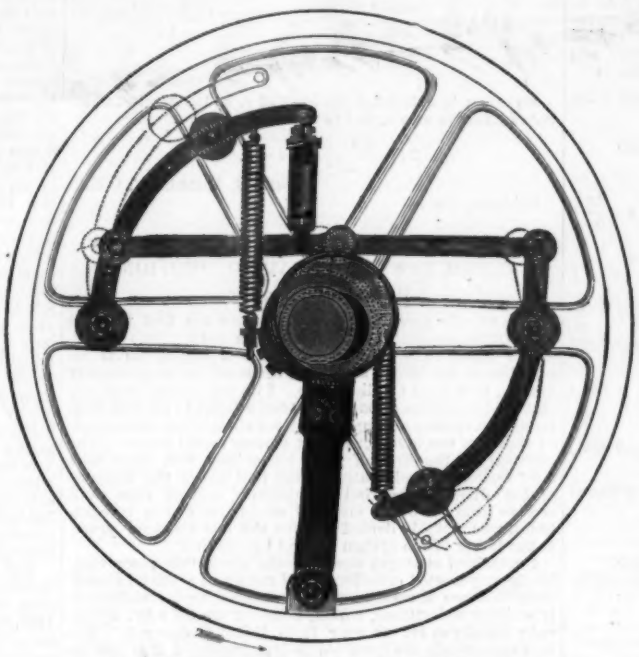
WITHIN the last few years steam engineering has taken a path into which it has steadily been drifting ever since the steam engine was invented. While the earliest engines had a velocity of but comparatively few feet per minute, the modern engine builder seeks to attain a velocity which is only limited by the resources at his command; and we find to-day that the piston speed of stationary engines is one of the main considerations which determines their applicability to various purposes.

The advantages to be derived from high speed engines has led many engineers to construct them according to various designs, each having its peculiar merit. They all have for their object the construction of an engine that shall be able to stand the wear which such engines are subjected to, and their valve and valve controlling mechanism must be such that it shall easily respond to a change of load, to which the engine may be subjected. An important point also in the life of these engines is the means employed for lubrication of the working parts. The old system of oiling twice a day cannot be applied here with safety, and devices must be employed for continuous oiling. Among the high speed engines which have lately attracted attention is the Ide engine, and to what extent these conditions briefly stated have been fulfilled will be shown by the following description.

The engravings on this and the following page show the front and rear of the engine, illustrating a new design, which is compact and graceful in outline, combining great strength and rigidity of parts.

The simple valve and entire valve gear and eccentric are shown in the third engraving. One turn of the handle on end of the eccentric rod permits the unhooking of the rock shaft, and the steam valve can be reversed by hand while steam is admitted to warm cylinder and steam chest before starting. This is specially desirable, as engines should never be started with cold cylinders. It is also sometimes very convenient to reverse the engine in starting and in adjusting the bearings. The bearings are fitted with bronze boxes, adjustable to compensate for wear.

A correct valve motion is obtained by placing the valve below the cylinder, and using a rock shaft. In all engines the piston travels faster on the back end of the stroke, and by this arrangement of parts a valve travel is obtained proportionately equal to the piston travel through each part of the stroke. This is an important point, especially in high speed automatic engines designed for heavy work and a wide range of duty, but is generally neglected with most of the builders, although an engine will not give perfect or equal indicator cards from both ends of cylinder if the valve motion is not correct.



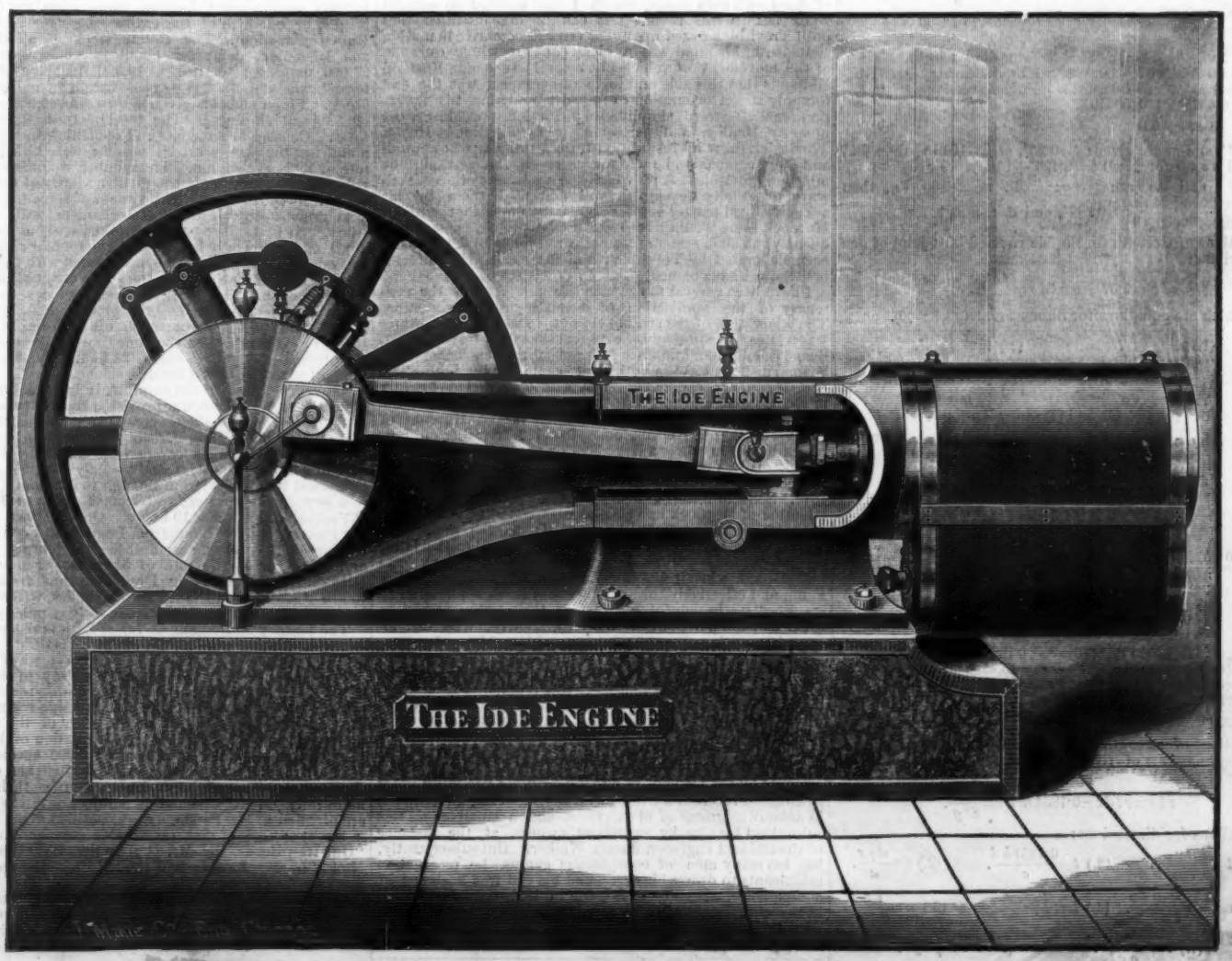
THE IDE GOVERNOR.

The important item of perfect regulation has also received its merited amount of attention in this engine.

The automatic safety governor is shown in position in the fly-wheel; the eccentric has a pocket projecting from the lower side to which a steel arm is bolted. This arm is pivoted near the rim of wheel. Opposite to this arm is a lug to which two steel arms are connected. These arms are connected to two bent steel levers, on which the fly-weights are placed. As these arms move out into the position shown by the dotted lines, the eccentric is carried across the shaft.

The movement of the eccentric is obtained from the centrifugal force of the balls, which movement is controlled by the spiral springs. The speed of the engine may be changed to suit requirements by shifting the weights or by tightening or slackening the springs. The springs hold the eccentric at a point which gives the valve full throw, until the engine is up to its speed, when the centrifugal force of the weight is greater than that of the springs, and the weights fly out, moving the eccentric into such a position that it shortens the throw of the valve, and at the same time advances the lead. The dash pot attached to the end of one of the levers controls the movements of the weights, preventing any sudden movement.

With regard to lubrication, it will be seen that all bearings are fitted with visible feed glass oilers. The cups being glass, the engineer can see when they need filling, which is accomplished by simply turning the cap one-eighth of a turn. This opens a large hole to receive the oil, and a vent to allow the air to escape. The feed of oil is regulated by the thumb-screw on top. Each drop of oil is seen as it passes from point of



THE IMPROVED IDE AUTOMATIC CUT-OFF ENGINE.

the pin through the opening to the bearing, and the engineer can always see and know that each bearing is being constantly oiled.

The quantity of oil required is very small, but it should be continuous, especially on the crank pin, pillow block, and eccentric. Each of these bearings has the oilers supported in such a position that they are in plain view, and the engineer can readily see if they are feeding constantly, and can fill them while the engine is running.

As will be seen from the illustrations and description, the construction throughout is thoroughly mechanical, and the results which have been achieved by this engine are fully equal to any constructed at the present time, while its advantages over a great many are manifest.

These engines are built by Mr. A. L. Ide, Springfield, Ill.

RIVETING.

NOTATION: Thickness of plate=t. Diameter of rivet=d. Clear distance between rivets in same row=s. Length of joint=l. Number of rivets=n. Number of rows=r. Distance between rows=h. Constant for tension=a. Constant for shearing=b. Constant for compression=c. Constant for deflection=g. Strength of joint=m.

Joints fail (1) by tearing across fibers of plate or cover, *i. e.*, in tensile strength; (2) by cutting the rivets, *i. e.*, in shearing strength; (3) by crippling, *i. e.*, in compressive strength; (4) by stretching due to bending of rivets (caused by too little iron between rows or between the rivets and end of plate), *i. e.*, in deflection strength; from which is

Equation of strengths for a lap, or single cover butt, joint of one row of rivets:

$$s\,t\,a = 0{\cdot}7854\,d^2\,b = t\,d\,c = \frac{t\,h^3}{d^2\,g}, \text{ from which are}$$

Equations for dimensions:

(1.) $d=\dfrac{t\,c}{0{\cdot}7854\,b}$. (2.) $t=\dfrac{0{\cdot}7854\,b\,d}{c}$. (3.) $s=\dfrac{d\,c}{a}$.

(4.) $s=\dfrac{0{\cdot}7854\,d^2\,b}{t\,a}$. (5.) $l=(d+s)\,n$. (6.) $n=\dfrac{l}{d+s}$.

(7.) $t=\dfrac{m\,(a+c)}{a\,c\,l}$. (8.) $d=\dfrac{m\,(c+a)}{0{\cdot}7854\,a\,b\,t}$. (9.) $h=d\sqrt[3]{c\,g}$.

Constants for strength from Trautwine's Engineer's Pocket Book, pp. 653–660:

a=24000, b=45000, c=60000, g=0·000055. (§ 22, p. 201.)

Illustrations of use of equations for dimensions:

(1.) If t is given: t=0·25″, then $d=\dfrac{0{\cdot}25''\times60000}{0{\cdot}7854\times45000}=0{\cdot}425''$,

and $s=\dfrac{0{\cdot}425''\times60000}{24000}=1{\cdot}06''$, and $h=0{\cdot}425''\sqrt[3]{60000\times0{\cdot}000055}$

$=0{\cdot}6375''$.

Proof:

0·25×1·06×24000 lb. =6360 lb. =tensile strength.
0·425×0·7854×45000 lb. =6383 lb. =shearing strength.
0·425×0·25×60000 lb. =6375 lb. =crippling "
$\dfrac{0{\cdot}25\times0{\cdot}6375^3}{0{\cdot}425^2\times0{\cdot}000055}$ lb. =6500 lb. = stretching "

(2.) If d is given: then $t=\dfrac{0{\cdot}7854\times45000\times0{\cdot}425''}{60000}=0{\cdot}25''$.

(3.) If t and l are given: t=0·25″, l=9″, then, as before, $d=0{\cdot}425''$, $s=1{\cdot}06''$, $h=0{\cdot}6375''$, and $n=\dfrac{9}{0{\cdot}425+1{\cdot}06}=6$.

Proof:

0·25×1·06×6×24000=38160 lb. =tensile strength.
0·425²×0·7854×6×45000=38290 lb. =shearing strength.
0·425×0·25×6×60000=38250 lb. =compressive "
$\dfrac{0{\cdot}25\times0{\cdot}6375^3\times1{\cdot}00000\text{ lb.}}{0{\cdot}425^2\times55}\times6=38600$ lb. =deflection "

(4.) If t and m are given: t=0·25″, m=38160 lb., then find d, s, and n as before, and $l=(0{\cdot}425''+1{\cdot}06'')6=9''$.

(5.) If l and m are given: l=9″, m=38160 lb., then $t=\dfrac{38160(60000+24000)}{24000\times60000\times9}=0{\cdot}247''$, and d, s, n as before.

Equations of strength for double covered butt joint of one row of rivets:

$$s\,t\,a = 1{\cdot}57\,d^2\,b = t\,d\,c = \frac{t\,h^3}{d^2\,g};$$

from which are equations for dimensions: (a=38500).

(1.) $d=\dfrac{t\,c}{1{\cdot}57\,b}$. (2.) $t=\dfrac{1{\cdot}57\,b\,d}{c}$.

(4.) $s=\dfrac{1{\cdot}57\,d^2\,b}{t\,a}$. (8.) $d=\dfrac{m(c+a)}{0{\cdot}3927\,a\,b}$.

and equations (3), (5), (6), and (7) as for lap joint.

Illustrations: If l and m are given, l=9″, m=38160 lb., then

$$d=\frac{38160\,(60000+38500)}{0{\cdot}3927\times38500\times45000}=0{\cdot}2525''.$$

$$t=\frac{1{\cdot}57\times0{\cdot}25\times45000}{60000}=0{\cdot}297''.$$

$$s=\frac{0{\cdot}25\times60000}{38500}=0{\cdot}39''. \qquad n=\frac{9}{0{\cdot}25+297}=16.$$

$$h=0{\cdot}25\sqrt[3]{\frac{60000\times55}{1000000}}=0{\cdot}39.$$

Proof:

0·39×0·297×38500 lb. ×16=72000 lb. =tensile strength.
1·57×0·25²×45000 lb. ×16=72000 lb. =shearing "
0·25×0·3×60000 lb. ×16=72000 lb. =crippling "
$\dfrac{0{\cdot}297\times0{\cdot}39^3}{0{\cdot}25^2\times0{\cdot}000055}\times16=72000$ lb. =deflection "

Equations of strengths for a lap or single cover joint of more than one row of rivets, each row to contain the same number of rivets:

$$s\,t\,a = r\,t\,d\,c = 0{\cdot}7854\,d^2\,b\,r = \frac{t\,h^3}{d^2\,g}.$$

Equations for dimensions:

(1.) $d=\dfrac{t\,c}{0{\cdot}7854\,b}$. (2.) $t=\dfrac{0{\cdot}7854\,b\,d}{c}$. (3.) $s=\dfrac{d\,c\,r}{a}$.

(4.) $s=\dfrac{0{\cdot}7854\,d^2\,b\,r}{t\,a}$. (5.) $l=(d+s)\dfrac{n}{r}$. (6.) $n=\dfrac{l\,r}{d+s}$.

(7.) $t=\dfrac{m(a+c)}{a\,c\,l}$. (9.) $h=d\sqrt[3]{c\,g\,r}$.

Equation of strengths for double covered butt joint of more than one row of rivets, each row to contain the same number of rivets:

$$s\,t\,a = r\,t\,d\,c = 1{\cdot}57\,d^2\,b\,r = r\,t\,d\,c = \frac{t\,h^3}{d^2\,g}.$$

Equations for dimensions:

(1.) $d=\dfrac{t\,c}{1{\cdot}57\,b}$. (2.) $t=\dfrac{1{\cdot}57\,b\,d}{c}$.

(4.) $s=\dfrac{1{\cdot}57\,d^2\,b\,r}{t\,a}$. (5.) $d=\dfrac{m\,(c+a)}{0{\cdot}3927\,a\,b}$.

Equations of strengths for pyramidal riveted lap joint:

$$(l-d)\,t\,a = 0{\cdot}7854\,b(d^2+2d'^2+3d''^2\dots) = t\,c\,(d+2d'+3d''\dots) =$$

$$\left(\frac{t\,h^3}{d^2\,g}=\frac{t\,h^3}{d'^2\,g}=\frac{t\,h^3}{d''^2\,g}=\text{etc.}\right)$$

when d = diameter of the rivet at summit of pyramid, d' = diameter of each of two rivets in row next to summit, and d'' = etc.

Equations for diameters of rivets, d being assumed or obtained by $d=\dfrac{t\,c}{0{\cdot}7854\,b}$.

(1.) $d=\dfrac{t\,c}{0{\cdot}7854\,b}$. (2.) $d'=\dfrac{d\,(a+c)}{2\,a}$.

(3.) $d''=\dfrac{d(a+c)^2}{3\,a^2}$. (4.) $d'''=\dfrac{d(a+c)^3}{4\,a^3}$.

(r^{th}) $d=\dfrac{d(a+c)^{r-1}}{r\,a^{r-1}}$.

Equation to determine the limit of r, or the greatest number of rivets in a row, and the number of rows:

$$2\,l-\frac{d(a+c)^{r-1}}{a^{r-1}}=l-d.$$

JOHN B. HOLBROOK, C.E.

Lebanon, Ohio.

THE CENTENARY OF THE APPLICATION OF STEAM POWER TO ROAD LOCOMOTION.*

By MATTHEW MACFIE.

IT is exactly a century this year since the first wheeled locomotive propelled by steam ran on a road. This event, which proved to be the introduction of a mighty social revolution on the face of the globe, occurred, as is commonly known, in a quiet Cornish town. I do not conceal from you that the present occasion is of special interest to me only in so far as it furnishes an opportunity for vindicating the neglected claims of the inventor of that pioneer model engine. The centenary of the birth of land locomotion will have been most unworthily celebrated during 1884 unless the memory of that distinguished but ungratefully treated man shall receive from the whole civilized world the fitting recognition unaccountably denied him for the last hundred years, as the father of the system of road locomotion.

I explained at length some months ago in this place that, by the unpatented introduction of gas as an artificial illuminant, William Murdock has laid mankind under sufficiently weighty obligations, which, however, up till now, apparently remain as far as ever from being discharged. But how enormously are these obligations increased if it can be proved, as I am convinced it can, that *his* brain was also the *fons et origo* of that prolific idea of a self-propelling carriage, first practically embodied in the tiny model, the work of Murdock's own hands, which I was enabled to exhibit when last in this room—if it can be demonstrated that until Trevithick gazed upon that crude locomotive in motion at Redruth, his mind was a blank on the whole question of the movement of vehicles by steam! It is admitted on all hands that this able and ingenious engineer was the first to apply steam locomotion to railways, and that his invention was afterward simplified by Blenkinsopp, improved upon by Hedley, and perfected by Stephenson. But if Trevithick drew his inspiration from Murdock, whose pupil and daily companion he was for years—if the germ in the mind of Trevithick, from which the vast network of railways eventually developed, was deposited there by his acknowledged master and teacher, it is plain that without Murdock there would have been no Trevithick, and consequently, no such system of rapid conveyance by land as has been elaborated by Trevithick and his mechanical successors whom I have named.

I have been careful to describe this new year as the centenary of the application of steam to road locomotion. The adaptation of the steam engine to move paddles in water was a later invention by four years than the former. William Symington, another almost forgotten benefactor, beyond dispute was the author of steam navigation. The first steamboat which ever sailed was constructed by him in model form, and successfully worked in Dalswinton Lake in 1788. The engine is still preserved in the Museum of Patents at South Kensington. In 1789, Symington propelled by steam power a large boat on the Forth and Clyde Canal. It was not until eight years afterward that Fulton succeeded in driving his vessel by steam on the Hudson. In 1812, Bell introduced his Comet on the Clyde. The attention of Murdock had also been directed to the use of steam power in the propulsion of boats, as the production of his oscillating engine clearly indicates. But the latter remained a model, and nothing more, until after many years had elapsed, when it was taken up by the Rennies and John Penn, and effectively turned to account in its application to steamboats. In painful contrast to the closing scenes in the life of the parent of the land locomotive, who had always borne adversity and prosperity alike with moderation, Symington's sun set amid clouds of disappointment and sorrow. The use of steam in the vessels employed by the Forth and Clyde Canal Company was ignorantly abandoned by them through fear of the banks being injured by the waves caused by the paddles, and the unfortunate inventor accordingly never reaped any profit, from an invention which has achieved on sea, as a medium of speedy transit from port to port all over the world, triumphs only equaled by those wrought by the locomotive on land. In his declining years Symington received a trifling gratuity from the government in acknowledgment of his services, and a small sum was subscribed for him by steamboat owners, at the instance of the eminent engineer, James Walker. But subsequently, like too many men of conspicuous genius, he resorted to intoxicants to drown his cares, and his end was hastened in consequence. He died in London in 1831, and was buried in the churchyard of Saint Botolph, Aldgate, being included with Murdock in the discreditable list of England's unhonored but illustrious heroes of science.

Not inappropriate to the centenary with which we are more immediately concerned would have been a historical review of the development of facilities for land transit before and since the adaptation of steam to land conveyance. It is not many generations since saddle bags were exchanged for wheeled carriages drawn by horses in England, amid widespread, but groundless, fear of the consequences. Indeed, it is but a comparatively short time since trunk roads existed throughout the country on which it was possible for vehicles to travel. The first locomotive was placed on a primitive railway in South Wales by Trevithick, in 1804 or 1805, just 80 years ago, being capable of drawing a load of 10 tons at a speed of five miles an hour. But its use was soon abandoned, owing to the rails being too weak to bear the weight. In 1813, Hedley discovered that the adhesion between smooth driving wheels and rails gave strong propelling power.

The first line of railway, that from Stockton to Darlington, was opened in the autumn of 1825. In 58 years from that date the civilized world has been girdled, so to speak, by the railway system, Europe and America respectively possessing 100,000 miles of iron highways. If existing lines were coiled continuously round the globe at the equator, they would go round it about ten times. For many years after the line formed next in succession (I mean the one between Manchester and Liverpool) skepticism was almost universal in regard to the safety and general practicability of carriages propelled by steam on two parallel bars of iron, as substitutes for coaches drawn by horses on the high roads. Contemporary engineers habitually sneered at the new *regime*, and predicted its early collapse; a distinguished statesman, for some time a Prime Minister, asserted that railways would be "the curse and ruin of the country;" the municipal authorities of almost every town at which it was proposed to form a railway station offered systematic and violent opposition to the project in and out of Parliament; the grandfather of the present Earl of Derby, who was, in this respect, a fair type of many other English noblemen and landlords, used the whole weight of his influence to prevent any railway from approaching those very estates which to-day have been immensely enhanced in value by their proximity to railway enterprise. For romantic interest the history of railway growth is an epic unsurpassed in the whole range of ancient and modern poetry. By 1840—15 years after the establishment of Stephenson's first line—only 1,435 miles of rails were laid down in the whole United Kingdom. At the present moment these islands boast 18,500 miles of iron highways, constructed at a cost of £767,899,570, which closely approaches the entire amount of our national debt. Exclusive of 599,568 season-ticket holders, 654,838,295 passengers, more or less, are being annually carried, and in addition 256,215,833 tons of goods. The receipts from the former source now reach £28,796,813, which is about equal to the annual interest charged on the national debt. The receipts from goods amount to £37-740,315, the working expenses being £36,170,436, the net earnings £33,206,688, and the average earnings on capital throughout 4·32 per cent.*

The population of the United Kingdom being roughly 35,000,000, the total railway traffic is thus somewhat less than nineteen times the population. In London alone in 1882, the Metropolitan, 22 miles in length, carried 61,805,516 passengers; the Metropolitan District, 13 miles in length, carried 31,907.751 passengers; and the North London, only 12 miles in length, carried 29,678,966 passengers. Thus in a single year the railways of the Metropolis, north of the Thames, altogether 47 miles in length, carried, apart from 117,630 season-ticket holders, more than 123,000,000 of people, or one-fifth of the entire passenger traffic of the United Kingdom. The rolling stock of all the British and Irish lines comprises about 13,000 locomotives, over 27,000 passenger carriages, 10,500 carriage trucks and horse-boxes, and 356,200 wagons for merchandise and live stock. Employment is given to between 300,000 and 400,000 officials and employes. The total of trains daily is about 1,500. Coming to accidents and casualties, in the first three months of the past year, 281 persons were killed, or at the rate of 1,124 per annum. The number wounded was at the rate of 4,400 per annum, the great majority of the sufferers being railway servants. The system of signaling is of itself a marvelous organization of mechanism well worthy of study. At first railways were worked without fixed signals at all, and it was only in 1838 that any regular code of signals was adopted. Now, the semaphore, fitted with these, one for the up and one for the down line, is in use at all the stations and junctions. The block system provides that no two trains shall be between any two block signal boxes—these boxes being distant from each other from two or three to six or eight miles—at the same time on the same line. In the process of signaling, every 24 hours 160,000 operations are performed by 13 000 hands.

As regards speed, if not comfort, in locomotion, it is difficult to conceive how better provision than at present can be made to secure these objects compatibly with safety. A distance of 800 miles, from Bristol to Aberdeen, can be performed in 18 hours, as compared with 10 days in the old coaching times; from London to Holyhead, 260 miles, in 6 hours and 40 minutes; from London to Plymouth, 247 miles, in 6 hours and a quarter; and from London to Edinburgh, 401 miles, in less than 10 hours. On the great Northern, the train at a given hour from London to Peterborough, a distance of 76¼ miles, accomplishes the journey in an hour and a half, or at the rate of 51 miles per hour. On the Great Western, the Flying Dutchman runs from Paddington to Swindon, a distance of 77¼ miles, without a single stoppage, going at a uniform space of 53¼ miles per hour.

The journey on this line as far as Bath is regarded as the quickest in the world. The distance is 106¾ miles; the actual time spent in traveling showing a speed of something over 52 miles an hour. What shall we say of the wizard's spell that conjures up a handsome dining-room, drawing-room, sleeping compartments, and dressing-rooms, running at full speed on rails! As an evidence of the strain imposed by railway industries on the legislation of the country, it may be mentioned that upward of 4,000 special Acts relating to railways have been passed, drafted, and debated by Parliament. Those who desire to gratify their curiosity more fully on the fascinating subject of railway progress are directed to Mr. Parsloe's work, entitled "Our Railways;" a recent edition of that remarkable compendium of facts, "Our Iron Roads," by Mr. F. S. Williams; "Her Majesty's Mails," by Mr. Lewin; and the "Life of George Stephenson," by Dr. Samuel Smiles.

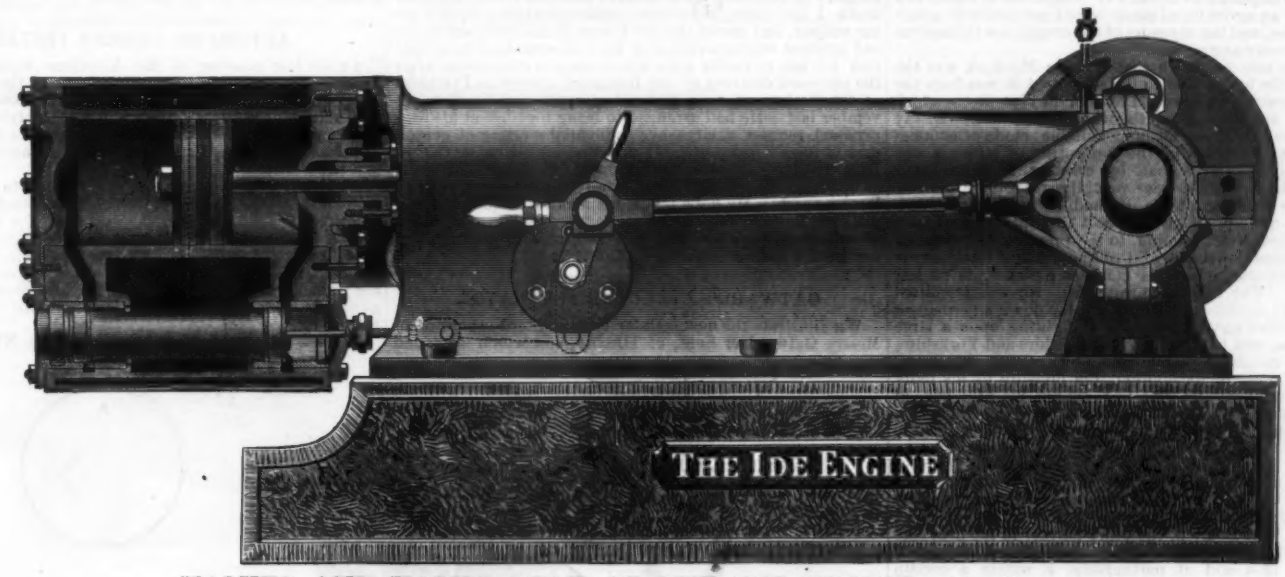
This hasty sketch would grow tedious if I were to pursue a similar line of investigation respecting railway construction on the continents of Europe and America, India and the

* A paper read before the Balloon Society of Great Britain, Jan. 4, 1884.

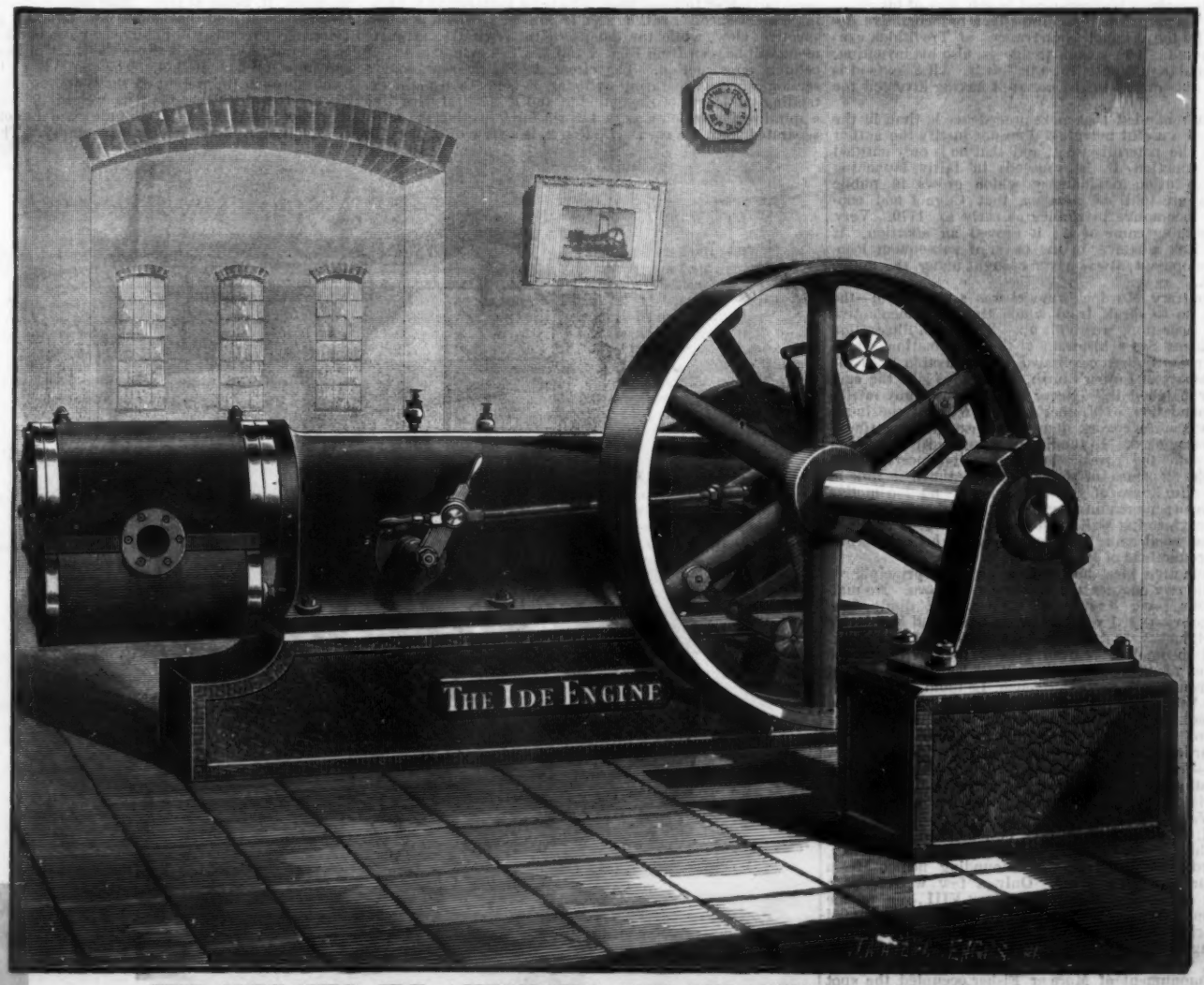
* "Our Railway Rates and Fares: a Plea for Unity of Administration." A paper delivered before this Society by Edward J. Watherston.

Colonies. The strides made by railway undertakings in the United States are so rapid and gigantic as to baffle attempts at an adequate realization of them.

The fullest and most comprehensive summary of statistics for the latter country is contained in the well-known yearly manual of American railways by Mr. Poor. What new phase in the working of railways may be introduced by electricity time alone can show, but it is morally certain that results are in store for us from electricity as a motor which may not improbably cast those of steam entirely in the shade. In estimating the prodigious accession to our national industry and wealth during the past half century, I do not think sufficient account has been taken of railways as a factor in the production of these elements. I have no wish to detract from the potent influence of the abolition of the Corn Laws in 1846, under Sir Robert Peel, in stimulating our commercial and financial activity; at the same time, we may sometimes be in danger of ascribing solely to the latter cause what is very largely due to the former. This leads to the further reflection that economical and productive administration is as yet very far from having reached its maximum under existing railway companies, and it is more than doubtful if the institution of railways will be rendered as subservient as it is capable of becoming to the manufacturing, agricultural, and commercial interests of the nation, until there is created for their administration a distinct and independent department of State. Not only must there be flagrant waste of resources to account for the restricted dividends paid by the best managing lines, but, in too many instances, also for the absence of dividends altogether. In 1881, no dividend was paid upon 269 different descriptions of stocks, and in 1882 this number had risen to 295. Eleven millions sterling of the ordinary capital of the London, Chatham, and Dover has never returned a shilling of dividend to the shareholders, and to all appearance there is very little likelihood of any payment whatever on this investment for a generation or two to come. The order of the day seems to be fresh additions to capital account without reference to making previous outlay remunerative. In 1882 a total of 49 millions of railway capital, being three millions more than in 1881, bore no dividend. It is not merely long-suffering shareholders, but the public at large that have to bear the penalty of the waste and mismanagement involved in this result. "At present," says a trustworthy authority on this subject, "it is not too much to say that we handicap our manufacturers in competition with foreigners by the excessive rates for inland carriage of goods and by the cost of the commercial traveling, which every one acquainted with trade knows to be enormous. Suffice it to say, that it costs more to send Middlesbrough iron from *Middlesbrough* to *Dover* than it does *to send it from Dover to Vienna and back*. A live Irishman is carried for one-tenth of the sum from *Dublin* to *Liverpool* than from *Belfast* to *Dublin*, and it is less expensive to send a pig to *London* from *Chicago* in the *United States*, than from *Waterford*, in *Ireland*." (Watherston.) The marvel is, that in an age when trade rivalry has reached fever-heat—when the odds are heavily against English goods winning their way in the markets of the world, owing to excessive fiscal charges abroad and the arbitrary and reckless railway charges imposed at home—many branches of trade are not extinguished. To refer specially to agricultural produce, hundreds of tons of asparagus were brought last year from Spain and delivered in Covent Garden at a less cost per ton than that of sending similar asparagus from one of our own inland towns. "We hear" (says the writer I have already quoted from) "of rents badly paid and of no rents at all—of farms even out of cultivation. And yet there may be food at one end of a line of railway wanting mouths, and mouths at the other end wanting food, and it neither pays to bring the mouths to the food nor the food to the mouths." An inquiry relating to the supply of fish has clearly demonstrated that it is preferable in many instances to use fish for manure than to send it from Lowestoft and Yarmouth to London by rail. Again, it might be clearly shown that millions of our people have never been on a railway in their lives. In Ireland the spectacle is to be seen of peasants carrying heavy loads of potatoes and other produce by the side of all but empty trains, owing to the traveling rates being virtually prohibitory to that class. It is in the adoption of some such system in respect to third-class trains and rates of carriage on staple commodities, as that by which Rowland Hill so beneficially revolutionized our postal arrangements, that we have to look for reform in railway admintistration. "A basket of apples,"



VALVES AND VALVE GEAR OF THE IDE ENGINE. (See first page.)



THE IMPROVED IDE AUTOMATIC CUT-OFF ENGINE. (See first page.)

says Mr. Watherston, "may not be worth more than one shilling at Appleham, yet fetch *five shillings* at Covent Garden, simply because the cost of transport between Appleham and Covent Garden amounts to four shillings. Reduce this to a fourth, and the basket might be sold for half a crown, an advantage of 100 per cent. to the buyer and of 50 per cent. to the grower. With cheap transmission the price of all commodities—food in particular—would naturally sink enormously in favor of the consumer, whereas its value to the producer would as assuredly rise." Let rates and fares be lowered, and the immediate addition to the traveling population, as well as to the goods carried, would transcend all anticipation, while no appreciable advance need be made in the expenditure of railway companies to effect this end. Many an agricultural estate would concurrently quadruple in value, and the revenues of the companies themselves would be greatly augmented.

Now, if it can be shown that William Murdock was the inventor of the locomotive in the sense that it was from the model constructed and worked by him in 1784, from which germinated and efflouresced the whole stupendous railway system, there could be no more suitable mode of commemorating the invention of the application of steam to the propulsion of carriages than by erecting to Murdock a memorial which shall at once worthily perpetuate his memory as the founder of the gas and of locomotive industries. I am quite prepared to admit that this eminent man sustained a less direct relation to the practical introduction of steam locomotion than he did to the practical introduction of gas illumination. But his merit as a pioneer is no less real in both. The difference was this: He was permitted personally to establish gasworks and lay down a permanent and an effective service of artificial lighting upon a large scale at Soho, and in the mills of Lancashire and Yorkshire, as well as in many warehouses and private dwellings. But in the case of locomotion, the pressure of his daily duties did not allow him time to carry out his idea beyond the initial stage. He invented an engine on wheels which actually propelled itself, but he left it to Trevithick—the pupil and friend, who derived his earliest conceptions on the subject from Murdock and from the study of his locomotive—to develop the seed into flower. The jealousy of Watt being aroused by the original model engine of Murdock, nothing but discouragement was thrown in his way by the former. But Boulton, the other partner in the firm who employed him, made him a generous offer of money to mature his idea, and of partnership, if within a certain period he should succeed in constructing a steam carriage to run at a given speed, capable of accommodating so many passagers and so many tons of luggage.

To fulfill these conditions would have necessitated his withdrawal from the labor on which he was dependent for a living, and Boulton's offer he was obliged to decline. But he revealed all he had discovered to Trevithick, who, profiting by Murdock's instruction, placed, in conjunction with Vivian, the first practical locomotive on a mineral railway at Merthyr Tydvil. What is the result? Last year, Trevithick was held up to the world by his admirers as the inventor of the locomotive, and a statue of him in that character accordingly was placed by them in Westminster Abbey; while the inventor of the first locomotive which actually ran on a road, the instructor to whom Trevithick was wholly indebted for the idea which he only had the merit of expanding, remains as completely uncommemorated, both as the introducer of gas and as the father of the locomotive, as if all classes in civilized countries had conspired to rob him of his rightful honors. The marked impulse given to locomotive development by the original contrivances of Trevithick cannot be ignored. The steam dredge is also his invention, and still remains substantially as he left it. All I contend is that he is not entitled to the honor of having invented the locomotive.

But I am reminded that mere precedence in time in the production of a useful invention does not justify the author in claiming the paternity of it, and that he is only entitled to this distinction if he succeeds in fairly launching it as an institution or industry which grows in public favor. We are told *ad nauseam*, that Cugnot had constructed a locomotive in France as early as 1770. Very true; but nothing came of it; it proved an abortion. It formed no link whatever in the chain of subsequent locomotive development; itwas never brought under the notice of Murdock.

On the contrary, Murdock's model was a vital germ—the protoplasm, so to speak, from which the entire locomotive system, by accretion, was built up. To use an illustration of the eminent Swiss historian of the Reformation, which event has recently been celebrated in connection with the fourth centenary of Luther's birth, "Erasmus laid the egg, and Luther hatched it." Never has there been any intelligent commendation of Luther's work without the indispensable preparatory work done by Erasmus being simultaneously recognized. In the line of apostolical succession composed of the great locomotive engineers, Murdock is the "prince of the Apostles," the first link in the chain. He knew of the existence of no locomotive before his own; his reading had not extended to the records of French engineering skill in this particular direction. All he knew of condensing engines was what he had learned from the productions of Watt.

The locomotive idea he grafted on the principle of Watt's stationary engines was absolutely his own. No matter what Sir Isaac Newton or Cugnot had dimly foreshadowed previously. I venture to maintain that Murdock's title to originality in the construction of the first working model locomotive is even greater than Watt's in the construction of his first engine. Watt had the engines of the Marquis of Worcester, Newcomen, Leupold, and Savery, and others before him, and although his was a very decided improvement upon theirs, his, after all, was only a further evolution of the principle embodied in theirs, but in the case of Murdock's locomotive, there was distinctly a new departure—an entirely fresh application of steam power: the foundation laid of an industry as original as it has proved to be prodigious, the possibility of which never entered the mind of Watt.

When I think of the arbitrary notions often acted upon by the public in preserving the memory of great services, I am hardly surprised at the astounding neglect from which Murdock has suffered. Only a few weeks ago a handsome equestrian statue of Henry VIII., one of the most inhuman tyrants that ever sat on a throne, was mounted on Blackfriars Bridge, owing, I understand, to the accident of the English Reformation having been introduced under his reign.

Had a monument of More or Fisher occupied the spot now disgraced by the statue of the royal monster, there would have been intelligent discrimination and elevated sentiment to respect in the selection. If such a perverted idea of a great national movement as is represented on Blackfriars Bridge be possible, can we wonder that Westminster Abbey holds a statue of Trevithick, and that no influential body has yet taken a single step to honor Trevithick's illustrious master, who imparted to him his first idea of locomotion, and was also immeasurably his superior in original and versatile genius?

To the culpable and widespread apathy respecting the claims of Murdock there is one noble exception among possessors of scientific fame and social influence. I refer to the late Sir William Siemens. That great engineer was with me heart and soul in my appeal for justice to the memory of Murdock. For months previous to his lamented death I had been in frequent communication with him on the subject, and one of the last letters he dictated before the sad accident which accelerated his end contained an invitation for me to confer with him as soon as convenient after the proposed delivery of his inaugural address as President of the Society of Arts, which had been fixed for 21st November last. He had arranged to bring together at his own personal request a large and influential meeting of gentlemen to form a committee for carrying out the memorial we have resolved to raise to Murdock. But the aid of Sir William in this undertaking is now irretrievably beyond human reach. My hope is that his mantle, as one able and disposed to do homage to Murdock, may fall on other men of science and station, who will co-operate in carrying out the work I have at heart to fruition.

GATWARD'S CELLULAR SEPARATOR.

WE illustrate the new cellular corn and seed separator of Messrs Gatward & Sons, of Hitchin, and which we found on their stand at the Smithfield Club Show. The general construction of this machine, which we understand is proving a great success, will be seen from Fig. 1, which is a perspective view, while the details of the separating arrangement will be seen from Figs. 2 and 3. The cylinders are of cellular construction. The circle, A, Fig. 2, represents a section of the separating cylinder, F being a trough extending the length of the cylinder, and E a spiral wire like a spiral spring which acts as a worm for collecting the seeds separated from the corn. D, Fig. 3, is a view of a piece of the stamped sheet metal of which the cylinder is made, B being a section of the same. As the cylinder revolves, the grain, such as wheat, falls out of the recesses, B, formed in the metal sheet, but the smaller seeds are carried higher, and do not fall out until they are tipped out by the inclination of the recesses, when about on a level with the center of the cylinder. They then fall into the trough, F, from which they are drawn by the spiral worm, E, and emptied at the end of the cylinder. By means of this separator seeds and weed seeds which cannot be separated by any other means are extracted. Wheat can be separated from oats by using a cylinder with larger cells. We understand that this separator is proving a great success, both at home and abroad, wherever it is in use.—*Iron.*

FIG. 1.

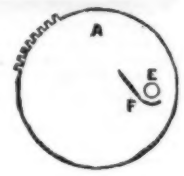


FIG. 2.

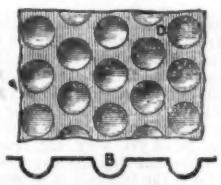


FIG. 3.

GATWARD'S CELLULAR SEPARATOR.

AUTOMATIC CEMENT TESTER.

AT the last meeting of the American Society of Civil Engineers a committee reported in favor of the adoption of a standard in cement testing, for the protection both of the user and manufacturer. Several different styles of cement testers are built, among them one by Fairbanks & Co., shown in the accompanying engraving, which is automatic in its action.

By referring to the figure it will be seen to consist of a scale beam, from one end of which a receptacle, F, is suspended. The other end carries one end of a lever of the second order, C. The clutches, NN, gripe a test piece shaped as shown at T, whose section is one square inch.

The box, B, is filled with shot and has a hole leading into the funnel, I; this hole can be opened and closed by sliding a piece of brass over it, and any shot that falls out is led into the can, F.

When a test piece is placed in the clutches, NN, the wheel, P, is turned until the scale beam barely touches the stop, K, the poise, R, being at zero. The sheet covering the hole is then slid back, and shot pours into the can, F. The beam gradually descends, till finally the piece breaks, and it falls. In so doing, however, it slides the sheet in front of the hole and stops the flow of shot. The contents of the can, therefore, represent the weight on the beam required to break the piece. In order to get the true weight in pounds, the can, F, and counterweight, E, are unhooked and changed about; E weighing as much as the can empty. The poise, R, is

FAIRBANKS' CEMENT TESTER.

then moved forward until balance is restored and the weight read off the scale, which will be the true load that broke the piece.

The machine is very quick in its action, and it requires less than a minute to get at the breaking weight of a specimen, which is a vast gain in time over the older forms.

NINES'S HORSE-POWER PUMPS.

THE accompanying Fig. 1 shows a movable pumping apparatus which its inventor, Mr. Nines of Paris, has arranged so as to be actuated by horse power.

The pumps, two in number, are capable of discharging, together, a hundred thousand liters (22,000 gallons) of water per hour. From one to four horses may be employed according to the height that it is necessary to force the liquid.

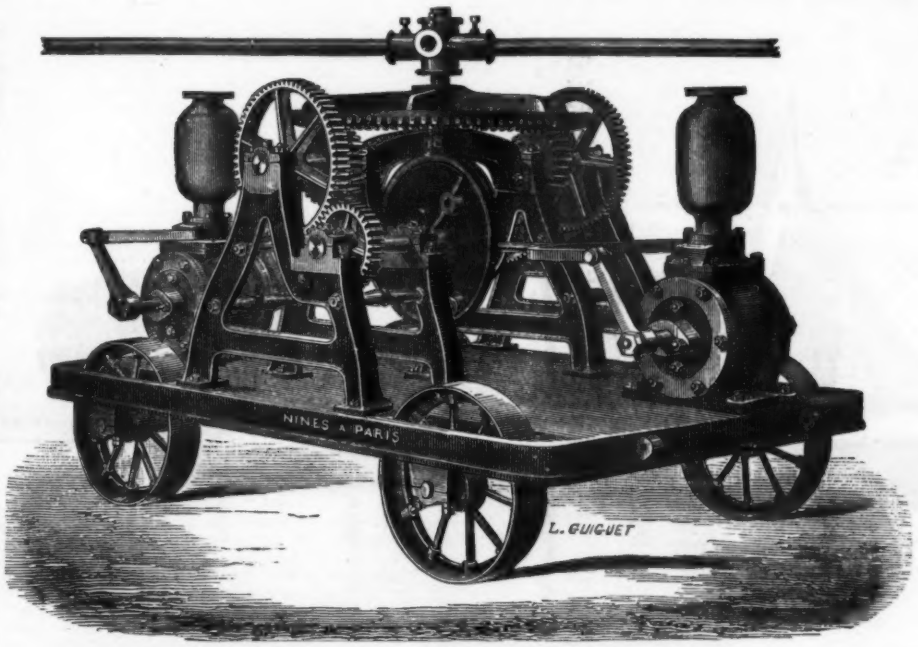


FIG. 1—NINES'S HORSE-POWER PUMP.

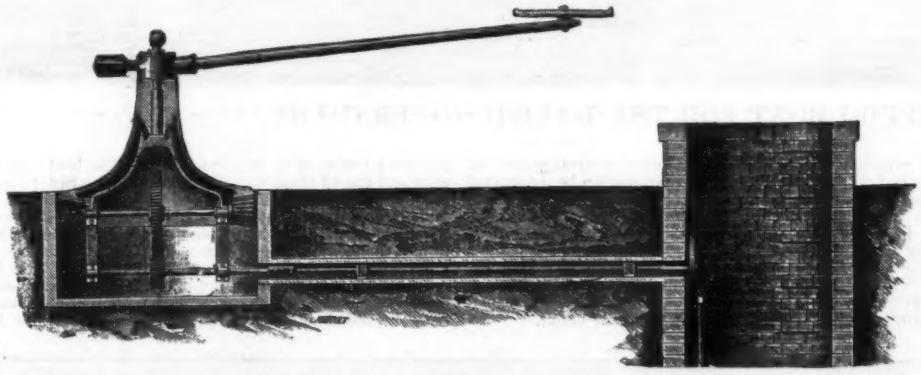


FIG. 2—HORSE POWER FOR ACTUATING STATIONARY PUMPS.

This combination presents several advantages. In the first place, the pumps being quadruple acting, the flow is always very regular, and, in the second, as they can be used singly or in combination, there need be no interruption in the work in case one of them breaks down.

This rolling apparatus will be found particularly advantageous for all agricultural purposes. FIG. 2 shows the Nines horse-power gear arranged for actuating a stationary pump. The details are sufficiently well shown to explain themselves.—*Chronique Industrielle.*

A NEW DRAWING INSTRUMENT.

By Prof. C. W. MACCORD.

THE objections to the ordinary form of pantograph are probably as well known as the instrument itself; it serves its one purpose satisfactorily, but it serves only one, and is both cumbersome and complicated.

The apparatus herewith illustrated is at least not open to the first of these objections, being as compact as a common beam compass, which it closely resembles in form; and in fact it may be used as such, as well as for enlarging or reducing drawings, and it serves either purpose equally well.

In appearance, then, it is as unlike the familiar pantograph as it well can be; and it differs from it just as widely in the principle of its action. The beam consists of two thin flat bars of steel, D and E, which are secured to the sockets, A and B, respectively, on opposite interior sides; thus the two bars lie one against the other, each sliding freely through the socket to which its mate is fastened.

Upon the lower edge of D is cut a rack, which gears with a small wheel, A′; and a similar rack on the lower edge of E gears with another wheel, B′. These two wheels have their bearings in two brackets connected with a third socket, or chariot, which slides freely over the two bars, D and E. One of these brackets is an extension of the chariot, C, itself, but the other one is attached to C, by steady pins and a thumb-screw, so that it can be removed at pleasure.

The axes of A′ and B′ are each provided with a fixed collar; in these collars are secured small steady-pins, fitting into holes drilled in two other wheels, *a* and *b*, which engage with each other; and thus the motion of one rack is transmitted to the other, its direction being reversed, and the velocity modified according to the numbers of the teeth upon the different wheels. By taking off the movable bracket just mentioned, the wheels, *a* and *b*, may be removed and others of different numbers substituted.

The ordinary pen, pencil, and plain points, forming the usual furniture of the beam compass, can be attached to either A, B, or C, the provision for which is shown at P. The mode of attachment has this peculiarity—that when the binding screw is loosened, the point in use has a small vertical play, and is pressed upon the paper by a light spring, S. The tube, P, is partly cut away on one side, allowing the spring to enter a groove turned in the shank of the pen or other point; rotation of the latter is prevented by the end of the binding screw, which enters a vertical slot in the shank; or a fixed pin in P may be used for this purpose.

A stand, W, with a heavy foot is provided for use in connection with this instrument when drawings are to be copied, enlarged, or reduced. The lower surface of the foot is covered with sheet India rubber (or may have fine projecting pins) to prevent slipping, and at the top of the stand is a plain round shank fitted to the bore of P, and thus either A, B, or C, at pleasure, can be provided with a fixed vertical axis of rotation. Let A, for example, be thus confined, while a plain point attached to B is moved over the outlines of a map; then a pencil carried by C will reproduce the same outlines upon a different scale, whose ratio to that of the original map will depend upon the relative diameters of the four wheels.

The relative velocities of the two moving sockets are determined by the following formulæ, viz.:

$$\text{I. (A—Stationary.)} \quad \frac{\text{Vel. B}}{\text{Vel. C}} = 1 + \frac{B'}{A'} \times \frac{a}{b}.$$

$$\text{II. (B—Stationary.)} \quad \frac{\text{Vel. A}}{\text{Vel. C}} = 1 + \frac{A'}{B'} \times \frac{b}{a}.$$

$$\text{III. (C—Stationary.)} \quad \frac{\text{Vel. B}}{\text{Vel. A}} = -\frac{B'}{A'} \times \frac{a}{b}.$$

It is clear that the same combination which will reduce a drawing say in the proportion $\frac{m}{n}$, will also enlarge it in the proportion $\frac{n}{m}$, by merely transposing the pencil and the plain point. From the above formulæ it is seen that by varying the position of the fixed standard, W, we have three different values for the ratio of reduction or enlargement, without altering the arrangement of the wheels at all; and again, since *a* and *b* may also be transposed, each pair of change-wheels, if of different diameters, should give six variations of the ratio—but in assigning definite and convenient numbers of teeth, it will sometimes happen that different combinations of the same wheels will produce identical results.

For many practical purposes the following set of wheels will be found satisfactory, viz.:

	A′	15	B′	30
Change wheels.	*a*	22	*b*	22
	a	15	*b*	30
	a	18	*b*	27
	a	20	*b*	25

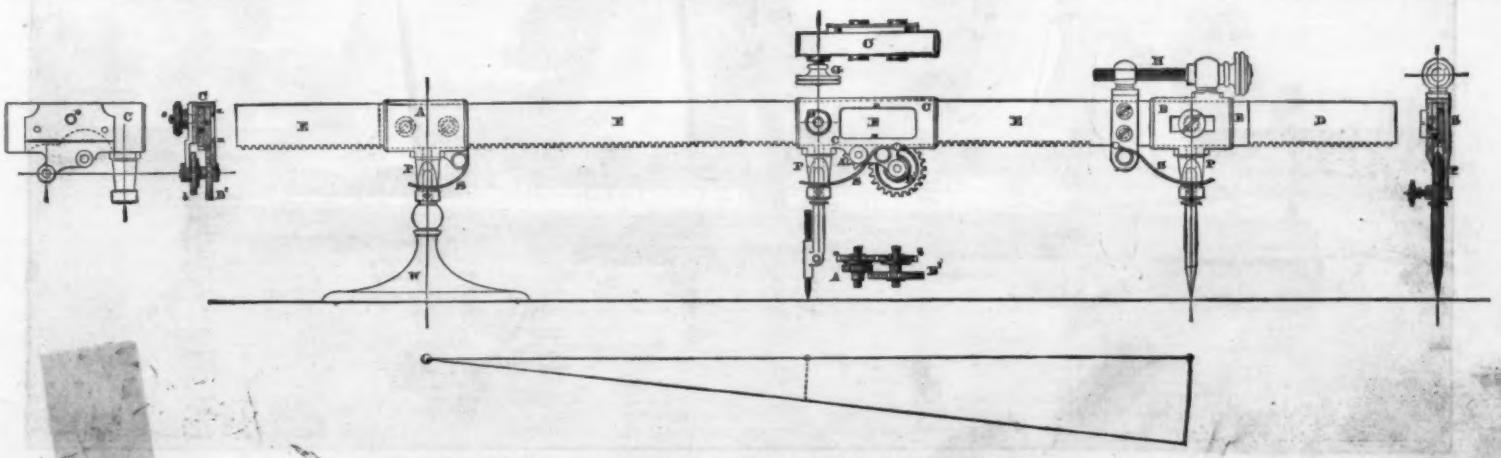
The range of the instrument in its capacity of a pantograph, attainable by the use of these four pairs of change wheels, is shown in the subjoined table, which gives in order the different proportions of reduction or enlargement, compared with the original as unity, as well as the combination of wheels and adjustment of the point and pencil sockets for each.

TABLE OF COMBINATIONS.

Enlargement.	Pencil.	Change Wheels. *a*	Change Wheels. *b*	Fixed Socket.	Reduction.	Pencil.
1	A	15	30	C	1	B
1¼	A	30	15	B	⅘	C
1½	C	27	18	B	⅔	A
1⅔	A	18	27	C	⅗	B
1⅘	A	25	20	B	½	C
1⅞	A	22	22	B	⅝	C
1⅘	A	20	25	C	⅖	B
1⅝	A	20	25	B	⅘	C
1¾	A	18	27	B	⅔	C
2	B	15	30	A	½	C
2	B	22	22	C	½	A
2⅓	B	18	27	A	⅓	C
2½	B	25	20	C	⅖	A
2½	B	20	25	A	⅖	C
3	B	22	22	A	⅓	C
3	B	27	18	C	⅓	A
3⅓	B	25	20	A	⅗	C
4	B	27	18	A	¼	C
4	B	30	15	C	¼	A
5	B	30	15	A	⅕	C

What precedes has reference only to the longitudinal motions of the traveling sockets; but due attention must be paid to their relative distances from the stationary one, in order that their transverse motions may have the proper ratio to each other. For example, suppose the instrument, in the figure, to be set for reducing a plan one-half by the first combination given in the table for that ratio.

It will be perceived that the chariot, C, travels in the same direction as the socket, B, with one-half the velocity



IMPROVED PANTOGRAPH AND BEAM COMPASS.

of the latter; so that if once set so that the pencil is midway between the plain point carried by B and the fixed axis of A, it will always remain so, and the transverse motions of B and C will have the constant ratio of two to one.

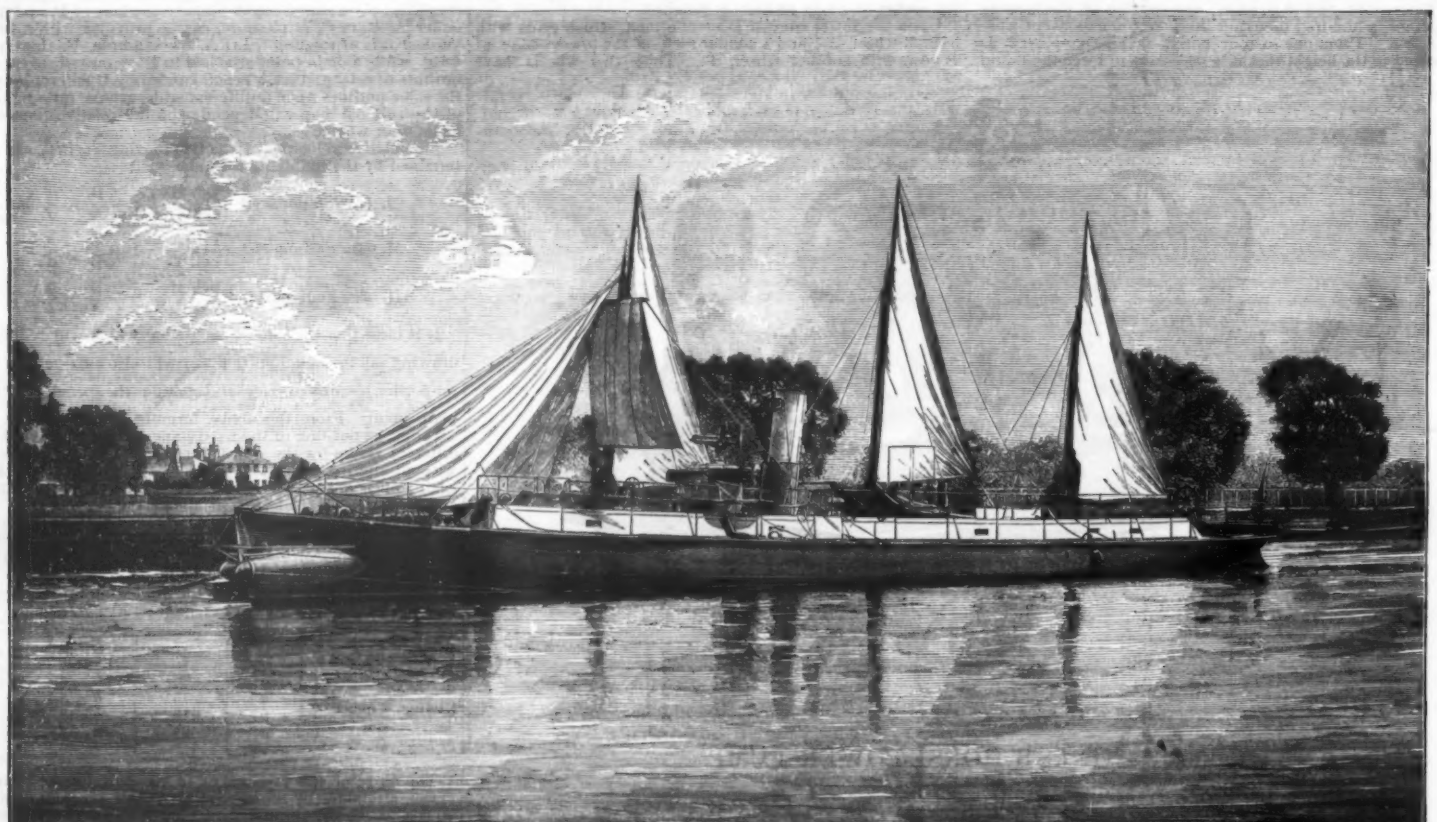
The required adjustment is easily made, thus: Let a plain point be first put in each of the sockets, A and B, and the distance between them marked off on a right line and bisected; when the change-wheels are removed from C the chariot can be run freely along the beam, and the pencil brought to the center mark; should it be slightly deranged in putting the change wheels in place, let the actual distance from A to the pencil be set off twice, after clamping C to the bars by the screw, G; then set the point of A again on its original mark, and bring the point of B into its proper position by means of the slow-motion screw, H. The adjustment is then complete, and removing the plain point from A, the fixed standard, W, is substituted for it, the clamp, G, loosened, and the instrument is ready for work.

The bars, D and E, may be made of any length that is found most convenient for the class of work to be done, and forms a convenient beam compass, capable of describing circles whose diameters are nearly twice the length of the bars. When used in the latter capacity, the change wheels should be set by the first combination given in the table, and C placed midway between A and B; those two sockets will then approach or recede from the central one at the same rate, thus keeping the instrument always in balance. When a finer adjustment is required than can be made by hand, the clamp, G, is tightened and the slow-motion screw, H, is employed as above mentioned.

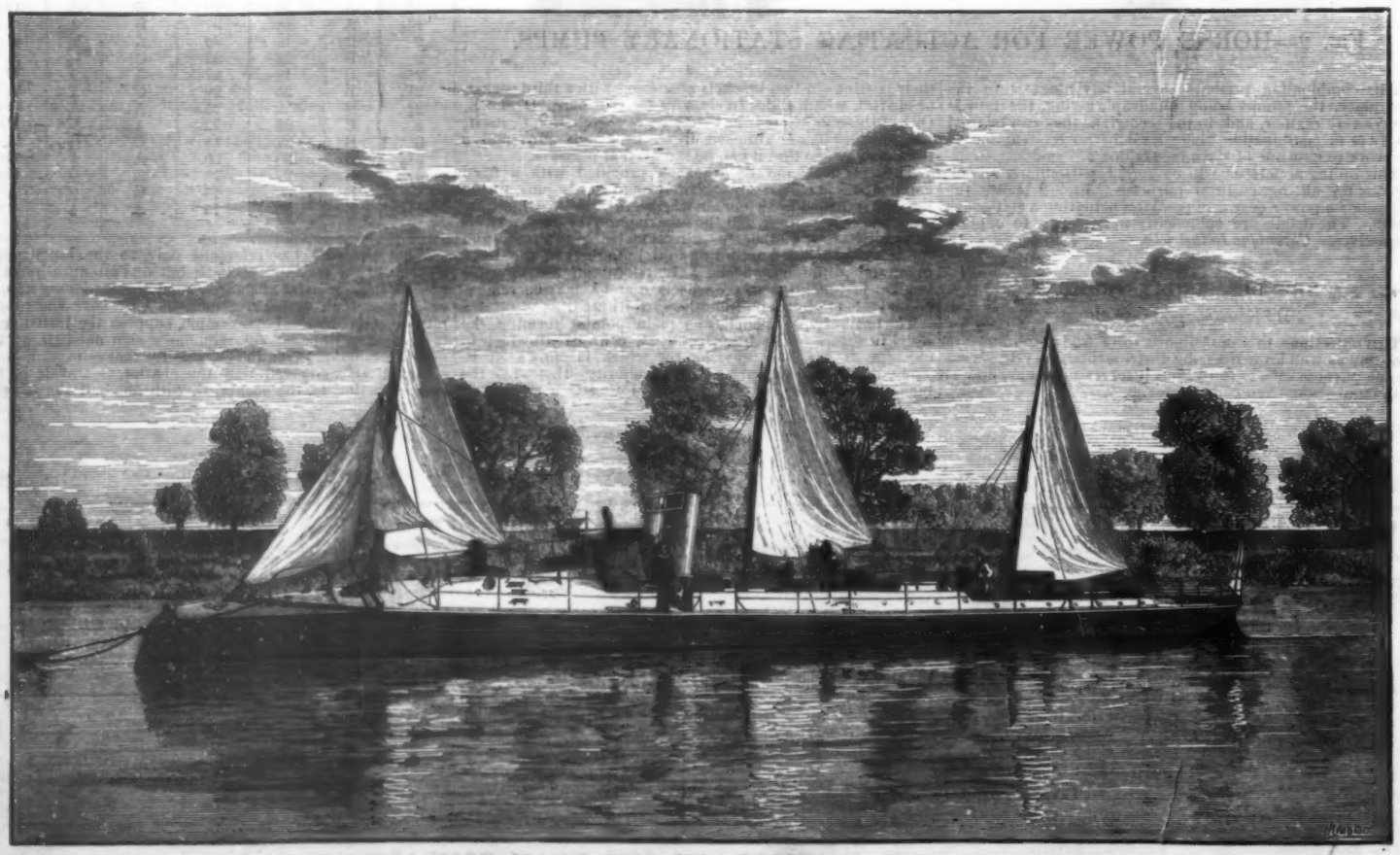
In principle, the action of this peculiar arrangement of racks and wheels will upon close examination be recognized as identical with that of an epicyclic train—the train arm (here represented by the chariot. C) revolving about an axis infinitely remote. The entire credit of making so happy an application of this principle, and of producing a pantograph of such unique and compact form, is due to Mr. J. M. Villa, M.E., of the United States of Colombia, although the writer, in making the design herewith presented, has introduced several modifications in points of detail.

NEW TORPEDO BOATS.

WE give illustrations of the two latest types of first-class torpedo vessels built by Messrs. Thornycroft and Co. The Russian boat is of the following dimensions: Length on water-line, 113 feet; beam (moulded), 12 feet 6 inches; depth, 6 feet 6 inches; draught forward, 2 feet 6 inches; aft, 6 feet; displacement, 60 tons. The hull is built of galvanized Bessemer steel, and is divided into eleven compartments by eight water-tight bulkheads and two half bulkheads in the manner introduced by Mr. Donaldson. The boat will float with any one of these compartments filled. Six powerful bilge ejectors are fitted. Two of these are placed in the boiler compartment, and are capable of ejecting 40 tons of water per hour each with a boiler pressure of 75 lb. In addition to the ejectors a bilge pump is worked off the main engines, and hand pumps are fitted for pumping the bilge from on deck. A separate steam donkey is provided, and the circulating pump, which is arranged with suction branches both in the boiler and engine rooms, as well as from



FIRST-CLASS TORPEDO BOAT FOR THE DANISH GOVERNMENT



FIRST-CLASS TORPEDO BOAT FOR THE RUSSIAN GOVERNMENT.

the sea, is guaranteed to throw 45 tons of water per hour.

The main engines are 14¼ inches and 24¼ inches in diameter, by 15 inch stroke, and were guaranteed to develop 750 indicated horse-power. They are of the now well known Thornycroft type of torpedo boat engines; they are fitted with a special valve by which they can be converted into non-condensing engines if necessary. Auxiliary engines are used for driving the fan blower and for the circulating pump, in addition to which there is the steam donkey referred to; the former are placed in the engine compartment, and the donkey in the boiler room, but both fan and donkey can be regulated from either compartment. A striking feature in these boats is the steam steering gear, which is fitted in the forward part of the conning tower.

The conditions which a steam steering gear for torpedo boat work has to fulfill are somewhat trying, both weight and space having to be reduced to the lowest points. In order to meet the necessities of the case Mr. Donaldson has designed a gear expressly for such requirements. This is lighter and more compact than any yet introduced; indeed, so far as regards weight no other steam steering gear at present in use can be said to approach it. During the trials of the Russian boat the helm was put from hard-a-port to hard-starboard by the steam gear in four seconds. Still smaller vessels than these first-class boats are fitted with steam gear for steering, the second-class boats also now being supplied with the Donaldson gear. These are no doubt the smallest craft in the world steered by steam, and indeed we should think are likely to remain so. In the first-class boats the bow rudder, which has been described in these columns, is provided; when used, it is worked in connection with the main rudder, either when the steam or hand gear is used. The boat can be steered either by steam or hand in the conning tower, or by hand by means of the wheel further aft, which may be seen in the engraving below. In the forward compartment is a Brotherhood air compressing pump, the engine and pump being self-contained on one baseplate. By this machine air is compressed to 1,500 lb. to the square inch for the purposes of charging the torpedoes and ejecting them from the impulse tubes.

In the forward compartment is also the electric light machinery, consisting of a Brotherhood engine and an M Gramme dynamo. A Mangin projector is used, by the aid of which objects are rendered visible at a distance of 1¼ to 1¾ miles.

The boiler is of the usual Thornycroft torpedo boat type. The total heating surface is 1,119 square feet, of which 1,032 square feet is supplied by the tubes, and 87 square feet is contained in the fire box. The grate area is 30 square feet; the area of the tube section is 4·74 square feet. It will be seen that in this small vessel of only about 60 tons displacement there are no less than seven separate steam engines, and the main engines alone are guaranteed to indicate 12½ horse-power per ton of displacement on full power runs.

The propeller is one of Thornycroft's patent; it has three blades, and is made of forged steel. The diameter is 5 feet 7 inches; and the pitch 5 feet 9 inches. As may be seen by the illustration given the end of one blade is considerably out of the water when the vessel is at rest, but even at a very slow speed the boat settles sufficiently by the stern to immerse the screw immediately on the engines being started ahead.

Both the Russian and the Danish boats are rigged in the manner shown in the engravings for the purpose of making long voyages; they spread 1,000 square feet of canvas. The three jib-headed fore and aft sails are hoisted by a sliding gunter. The masts can be readily unstepped and stowed away or left ashore. The armament of the Russian vessel consists of four 19 foot. Whitehead torpedoes, each 15 inches in diameter. Each of these carries a charge of 80 lb. of guncotton, and is capable of propelling itself for a distance of 1,000 yards at a speed of from 18 to 19 knots per hour. Two single barreled 37 mm. Hotchkiss machine guns are placed on the gunwales on either side of the conning tower. The Danish boat carries one five barreled 37 mm. machine gun on the top of the conning tower.

The accommodation both for officers and crew is of a somewhat exceptional character for torpedo boats. The officers' cabin aft is fitted with four berths, which are arranged in the same manner as those usually seen on board yachts of from 20 to 30 tons. The fittings are of polished teak, which has been especially selected for the purpose, and with the navy blue hangings gives a handsome and comfortable appearance to the cabin. The floors are of oak. Considerable ingenuity has been displayed in using up all available space for lockers, cupboards, and other conveniences, and indeed throughout the idea of the designer has evidently been to make these boats comfortable homes for extended cruises. There is also in the after part of the vessel a steward's pantry, which is well furnished with plated and china service; beyond this is a lavatory and wardrobe cabin, adjoining which are the small arms room and ammunition lockers, and officers' w. c. The after peak is used for stores and fresh water for officers' use, and is accessible from the steward's pantry, from the officers' cabin, and from deck.

In the fore part of the boat there is accommodation for a crew of twelve hands, including petty officers and men, hammocks being slung for the latter, while the petty officers are provided with seat beds. All space is well occupied in this part of the vessel; lockers being placed in every available corner, affording good stowage for clothes and stores. The characteristic feature in the Russian boat is the position of the ejector tube used for discharging the torpedoes, which is placed in the fore part of the vessel. As will be seen from the illustration, a raised deck extends from the conning tower to the stem of the boat. At the extreme forward end a hinged cover is placed which opens outward and discloses the port through which the torpedo is launched. This appears to be in many respects a preferable arrangement to that shown in the illustration of the Danish boat, in which the torpedoes are ejected through two tubes projecting one from each bow a short distance above the water-line. In all the leading features excepting the torpedo ejecting apparatus, the boats we illustrate are alike. In the Danish vessel, however, the machine gun is, as we have stated, mounted on the conning tower, while the Russian boat has her guns at the sides, as described.

There are three contract trials for all the first-class torpedo boats that Messrs. Thornycroft and Co. now build. A three hours' speed trial is run; a 100 mile coal trial, and a six knot speed trial. The following are particulars of the mean results of the Russian boats' trials.

Three hours' full power trial: Mean speed 18·97 knots; boiler pressure 129·5 lb.; vacuum 24·16 inches; air pressure for blast in stokehole, 2·21 inches of water; revolutions per minute 404. Six hours' full speed trial made on the measured mile in Long Reach. Mean speed of the six runs with and against tide at the rate of 19·506 knots per hour. Boiler pressure 130 lb. Revolutions 413 per minute, vacuum 27 inches. Air pressure in stokehole 2·83 inches. The slip of the screw was 17·13 per cent. of the speed. These and the following were the official trials made by the Russian naval authorities, and were conducted according to the Admiralty regulations.

In the one hundred mile trial, made to test the coal consumption, run between the Nore and Purfleet, the vessel steamed 103·8 knots in 9 hours 20 min. One ton of Nixon's navigation was weighed on board for this run, and at the end a few pounds still remained. It may be said therefore that the vessel will run 104 knots at eleven knots speed on a ton of coal. These boats are guaranteed to run a thousand miles at eleven knots on their own coal.

On all the above trials the regulation official weight of stores and gear was on board, amounting in all to 16 tons 14 cwt. and 26 lb. This includes coal, armament, ammunition, fresh water in tanks, crew, etc., but not the water in boiler.—*Engineering.*

SMOKE CONSUMING FURNACE.

THE vertical limb of the air pipe opens at the bottom into the ashpit at B, the far end of the horizontal limb at A opens upward into the flue through a small grid, which is intended to split up the incoming air. The action will be readily understood. The air is drawn from underneath the grate, and,

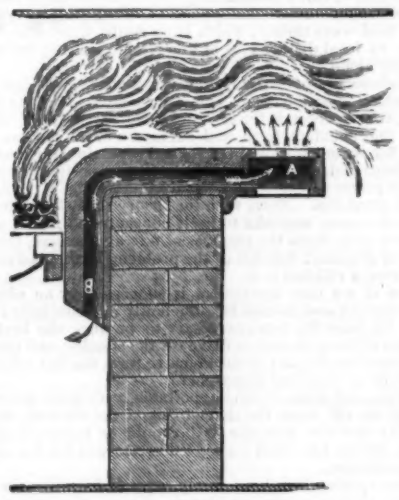


FIG. 1.

traveling through the tubes as shown by the arrows, becomes heated thereby. Passing through the grid, A (Fig. 1), it impinges in this heated state upon the heated gases coming from the fire, and consumes them under the most favorable conditions. The arrangement has the merit of simplicity, consisting only of a series of pipes that can be laid in position on the bridge by any bricklayer. It contains no moving parts that have to be adjusted after every firing by the stoker, and it is claimed to be self-regulating, that is to say, the harder the fire is forced the greater the quantity of air that is drawn through the bridge.

We saw a number of interesting experiments carried out to show the efficiency of this arrangement. When the furnace was fired up, the door being open, the cold air rushing in over the fire, through the door in preference to through the bridge, caused the formation of black smoke; the door being closed, however, the smoke ceased absolutely altogether. The door still remaining closed, a mass of clay was placed in the ashpit against the openings of the bridge, for the purpose of cutting off the air supply through the pipes; the smoke then reappeared and continued for several minutes,

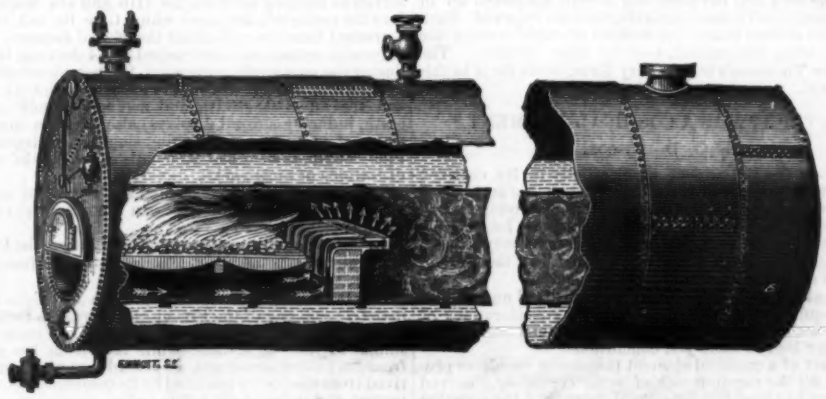


FIG. 2.—SMOKE BURNING FURNACE.

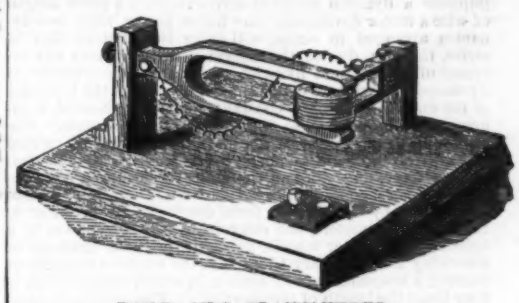
and disappeared when the clay was removed. The experiments were varied in several ways, but they always showed that the tubular bridge could be relied upon as an efficient smoke preventer. The makers are the Metallic Tubular Bridge Smoke Prevention Company, of London.

CONVERSION OF LIGHT INTO ELECTRICITY.

THE conversion of electricity into light is now a fact of every-day utility, but the reverse process has been very slow of accomplishment. It has, however, been effected by Herr Sauer, whose sunlight battery has been described in the *Electrotechnische Zeitschrift*. The chemical rays furnish the power, and the battery will only act in sunlight. It consists of a glass vessel containing a solution of fifteen parts of table salt and seven parts of sulphate of copper in 106 parts of water. In this is placed a porous cell containing mercury. One electrode is made of platinum, and the other of sulphide of silver, and both are connected with a galvanometer. When not in use the whole is inclosed in a box. When in use, the platinum electrode is immersed in the mercury, and the other in the salt solution; the battery is placed in the sunlight, and the galvanometer needle is then found to be deflected, the sulphide of silver being the negative pole. If the sun is clouded, or any other change in the intensity of the light occurs, it is indicated by the needle. The exact effect produced by the light rays does not as yet appear very clear; but their presence distinctly produces electrical action, and their absence suspends it.—*Engineering.*

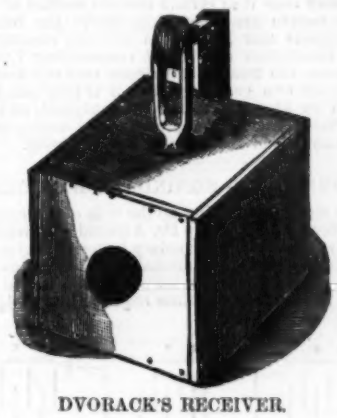
DVORACK'S APPARATUS FOR TRANSMITTING SOUNDS

THE accompanying figures represent the ingenious apparatus devised by Mr. Dvorack for transmitting sounds, as shown at the recent International Exhibition at Vienna.



DVORACK'S TRANSMITTER.

The apparatus consists of two parts. The first of these, the transmitter, consists of a tuning fork which is set in motion by an electric current. The second, the receiver, likewise consists of a tuning fork, and is inclosed within a sonorous wooden box and connected with the other by a



DVORACK'S RECEIVER.

conducting wire. The sounds transmitted from the tuning fork of the transmitter to that of the receiver are re-enforced by the sonorous box and become musical sounds whose waves are continuous.—*L'Electricité.*

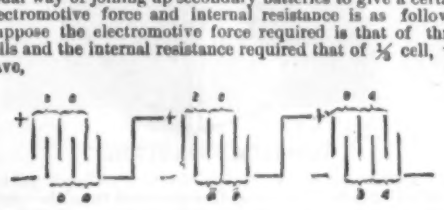
A HYDRO ELECTRIC SIPHON.

UNDER this title Mr. Hiram S. Maxim proposed in the early part of 1881 a most ingenious scheme for draining the valley of the city of Mexico by means of electrical power generated by the fall of water raised by electrically driven pumps. The city of Mexico is situated in a basin of volcanic origin surrounded by mountains, and is thus the center of a circular watershed from which there is no escape for the rain except by evaporation. The bottom of the basin is, however, several thousand feet about the sea level, the country falling away on the further side of the mountains in all directions and in some parts very rapidly, so that there would be no difficulty in disposing of the drainage if it could be lifted over or carried through the mountains. Three hundred years ago the Jesuits commenced a deep cut through one of the passes, and the work was carried on from time to time until hundreds of thousands of dollars had been spent. Unfortunately the engineers failed to establish the proper level, and when the cut was finished it was found to be forty-five feet too high to accomplish its object satisfactorily. A small river, which has formerly discharged itself into a lake in the valley, was diverted through the new channel, and thus the severity of the floods was somewhat abated, but still the relief was far from complete. Under these circumstances Mr. Maxim was consulted, and three schemes were laid before him; the first was to deepen the cutting, the second to drive a tunnel, and the third to resort to pumping. Unfortunately the expense in every case seemed to be an insuperable obstacle, and he was driven

to look for other means. Upon examining the map he noticed that when the water was once raised high enough to flow through the channel it could be made to develop power outside the cut, where the descent is very rapid. He therefore proposed to raise the water out of the valley by pumps driven by electricity, and to generate the current by water-wheels and dynamo machines placed outside the cut. The water needed to be raised 15 meters, and the power required was 7,000 horse power. The plan was to place a large number of water wheels upon the outside of the valley where the descent was most rapid, and to use them to drive dynamo machines connected to similar machines inside the valley. The water already flowing through the cut could be relied on to fill the dams and start the operation. The electrical arrangements were based upon the following considerations: Suppose a dynamo machine drives through a given length of wire a motor developing one horse power, then two dynamos, arranged in series, will drive two motors, also in series, through double the length of wire without any increase of current, and likewise ten or any other number of dynamos will drive an equal number of motors, the intensity of the current remaining constant, while its potential is increased in proportion to the number of generators. The only limit to the length of the series is the point at which the current becomes unmanageable from its high electromotive force, and thus an enormous power might be transmitted along a conductor of very moderate size. Mr. Maxim argued that by utilizing the force developed by the water in falling, say, 60 meters, and converting that into power by a succession of water wheels, he could raise the drainage of the valley the necessary 15 meters, the whole arrangement bearing a resemblance to a siphon in which the long leg is four times the length of the short one. The scheme was laid before many of the scientific men of America, including Professors Henry Morton, George W. Barker, Messrs. G. Farmer, Young, Henry Draper, and others, and they all indorsed the correctness of the principle upon which it was based, although they naturally foresaw that great practical difficulties would arise in carrying it out. The possibility of transmitting power along great lengths of small conductors has since been demonstrated by M. Marcel Deprez, and we may take it as certain that the method of transmission will receive great developments in the future. We hardly suppose that Mr. Maxim seriously contemplated to risk an installation capable of transmitting 7,000 horse-power upon the meager experience that was available for his guidance two years ago, but it is interesting to know that such an idea was actually promulgated, and received the criticism and general approval of the leading authorities on the other side of the Atlantic.—*Engineering.*

CONNECTING SECONDARY BATTERIES.

A NEW method of joining up the cells of a secondary battery has been introduced by Dr. Alexander Muirhead. The usual way of joining up secondary batteries to give a certain electromotive force and internal resistance is as follows: Suppose the electromotive force required is that of three cells and the internal resistance required that of ⅓ cell, we have,



where *c* and *c* are thick bars connecting the plates. The bars are made thick in order to keep down the internal resistance. Dr. Muirhead's method is represented thus:

It will be seen that the three sets of cells are joined up in parallel circuit, and fewer connecting bars are required. Each cell consists of four plates, one surface of each (except the first plate) being peroxidized, and the other metallic. The dry pile, or Thomson's tray battery form, lends itself to this arrangement.

ELECTRICITY AS A COSMICAL ELEMENT.*

By G. D. HISCOX.

IN introducing the subject of electricity in its complex relations with the bodies of our solar system that are beyond our immediate ken, it is not expected that our young society is to solve a mystery that is now puzzling the leading astronomers of the whole world; nevertheless, it may assume the privilege, like the leaders of investigation themselves, to put the question, and indulge in its vagaries.

Our specialty cannot at present cover original and experimental inquiry, but the suggestions and considerations of the many who are engaged in this work, when brought together, may lead to some just conclusions.

The want of a cosmical element possessing repulsive properties to fill the requirements of some especially observed phenomena has been felt for several years, and the question has been asked, "Is there an unknown force of repulsion whose laws are still a mystery?" or "Is the heat developed by the chemism of the sun an ample repulsive energy?"

The suggestions in answer come from many investigators, and with much force; that, instead of looking for some unknown and mysteriously hidden element, we direct investigation to a mysterious and partially known element having no ponderable potential, yet with a wonderful activity, whose velocity of flight is the greatest of its marvelous powers.

Its power of penetrating and disintegrating solid and gaseous bodies; its passive or allotropic condition as illustrated in magnetism; all seem to point, in the minds of investigators, to electricity as one of the leading cosmical elements.

Starting with the assumption that there are imponderable as well as ponderable elements that contribute to the sum total of created energy, we suggest the relation of electricity as the activity, or impulsive; magnetism as the passivity, or allotropic; gravitation as the densitivity, or binary; and light, heat, and sound as the vibratory, or a gradation of the elements of vibration.

The activity of electricity may be made more appreciable by the statement that its velocity in an aerial wire of iron which has large resistance is about 30,000 miles per second. While Kirchhoff's experiments gave a velocity in a wire of high conductivity, of 192,000 miles per second, which is fully equal to the assigned velocity of light, Wheatstone's experiments gave the enormous velocity of 288,000 miles per second. This requires verifying.

The assertion that a Torricellian vacuum is not a conductor of electricity has lately been disproved by the experiments of Professor Edlund in Sweden, who has shown by a system of induction currents that a space so rarefied as to resist the discharge from electrodes becomes luminous by induced currents.

If vacuity is thus a conductor, and air and other media rarefied to the limit of vacuity, are conductors and recipients of electric activity, then, why require even a perfect vacuum in space for the stability of planetary movements, when there is a possibility that an imponderable element may fill all space in combination with a rarefied ethereal medium in which the ponderable elements of worlds, comets, meteoric and gaseous bodies may sail the rounds of their stated orbits in obedience with the laws of gravitation and electric repulsion?

Zollner has made a special study of and has endeavored to show that the known laws of electricity are altogether sufficient to explain the erratic sweep of the tails of comets out of their orbital paths. For, notwithstanding the doubting denial of this assumed fact, the observations of this condition are too numerous and positive to be lightly swept aside by a tidal wave theory, which is no doubt thoroughly applicable to local disturbance of ponderable gaseous matter by gravity alone.

Professor Boss, of the Dudley Observatory, who has taken a leading position upon cometary matters, in a late article says, that to account for the backward curvature of the jets and the peculiar form and curvature of the tail, we must look for some additional force; and that in all probability this force resides in the sun—is directly opposite in its effects to the power of gravitation—and suggests this force as electrical repulsion. Now, with the theory that electricity may pervade space, and take to itself concentrated forms, as it is known to do upon the confines of our atmosphere, the solution of this most difficult of the problems of the past century becomes a rational one.

For if we may assume, as is suggested by an observer, that the sun and comets be sufficiently and similarly electrified, we have the force necessary to produce the backward curves of the jets, and to drive off the smallest and probably outermost molecules of the coma to form the tail within the folds of an electrical atmosphere.

Since, according to this hypothesis, very little matter can be given off from the shaded side of the nucleus, we may readily perceive why the tail should be hollow in appearance, which has been suggested to account for its extreme transparency.

The opinion has been lately expressed by Huggins, who favors most strongly the electric theory, that the positive and negative conditions of ponderable matter, whether gaseous or solid, under the influence of electric action may fully account for the sudden changes in the form and condition of cometic phenomena.

The vast rate of expansion of these appendages, and the immense velocity with which they traverse their perihelion passage in an orbit spread out millions of miles beyond the orbit of their nucleus, precludes the possibility of any longer holding to that other and strait laced element gravity, alone to account for such erratic movements.

The only apparent evidence of the self-luminosity of the tail of a comet was exhibited by the great comet of July, 1861, which was reported in England as having swept so near to the earth's position that astronomers declared that the earth must have been enveloped within its immense tail on the 31st of that month; many observers reported that the atmosphere and sky upon that night had an unusual and peculiarly luminous appearance.

A curious phenomena was observed in the Pons comet that does not seem to belong to the condition of reflected or direct light. When viewed with the spectroscope, the three faint bands seem to change in a few seconds several degrees in brightness, while the variability of the nucleus was observed as ranging between the 11th and 7th magnitude before the perihelon, and since which time its tail has shown a gradual increase until about the 26th of January, when its expansion seemed to have reached 3 or 4 degrees; the weather during the past week preventing further observation.

Why may not the sun spot or electric outbursts from the sun, that affect the electric and magnetic conditions of the earth, inducing auroral displays, also affect an auroral condition of comets, producing the singular variations in the light, length, and form of their tails as well as the mysterious distortions of their nuclei.

These phenomena have excited the wonder of observers in all ages, perhaps none more so than the observers of the present comet.

In this strangely erratic physical condition, the Pons comet is not alone; it is more or less an essential feature of all comets.

In late investigations in regard to an unassigned element in the corona, one of the French observers (M. Tachini) at the Caroline Islands describes the coronal spectrum as being similar to that of comets, while Angstrom has suggested, from his own observations, an accordance of all spectra derived from electricity modified by its combinations with other matter, and in this light refers to the anomalous spectra of the corona, which has been observed at times to have given an apparently superimposed spectra of electricity as exhibited by an electrode in rarefied air and the aurora, in combination with the spectra of hydrogen and other ponderable matters, as illuminated by the intense light of the sun. He has shown that the spectrum of the aurora and the zodiacal light are similar, being of a monochromatic character with a line not assignable to any known ponderable matter. Other observers have extended the divisions of this supposed electrically combined spectrum to the number of 15 to 20 lines. Again, the American observers of the eclipse of last May, with a single exception, report coronal spectra showing a variety of divisions corresponding to at least three elements in its composition, of which radiant light and a ponderable body are the principals; the third being described as a glowing vapor which has a correspondence in the spectral line 1474 *k*, which in its fickleness baffles any uniformity in spectroscopic results. It was assigned to the sphere of a gas lighter than hydrogen.

Why not say electricity?

If spectral line 1474 *k* represents an unknown element other than electricity, some well planned experiments ought soon to define its spectrum in its various superimposed combinations, from which more rational and positive deductions may be drawn.

Thus, the varying phenomena of the ever fickle corona may have led to the suggestions and conclusion of Professor Hastings, that it was a subjective phenomenon largely due to the diffraction of light.

This conclusion has not been accepted by European physicists, and is probably contradicted by the late experiments of Huggins in England, who has not only exhibited, but actually photographed, the corona by the arrangement of an artificial eclipse within the telescope, by means of the interposition of a blackened disk a little larger than the image of the sun at the focal point, thus enabling the formation of the coronal image free from the assigned causes of diffraction.

Further, it has been asserted by Sir W. Siemens, in a discussion of the solar constitution, that the sun has a high electrical potential, due, in his opinion, to the friction of the dissociated matter which is constantly revolving in its chemical relations upon the sun's surface.

This conclusion was probably drawn from the observed reactions of heat as evolved in the terrestrial atmosphere, the eruption of volcanoes, and the electro-magnetic disturbances received by the earth corresponding with the eruptive displays upon the solar surface.

To still further illustrate the drift of the thought of leading thinkers in this relation, Professor Langley, in describing a remarkable coincidence of sun spots and aurora, says "that the occult nature of the relation between spots on the distant sun and the aurora is still one of Nature's most hidden mysteries; that there is such a probable relation, however, such occurrences as this constantly remind us."

When we consider the almost instantaneous electro-magnetic connection between the sun and the earth, and as probably between the sun and every molecule of ponderable matter in the solar system, and the possibility that the sun is surrounded with a deep electric atmosphere which is constantly being disturbed by the causes that affect the mysterious breaks in its photosphere, can we not venture to assume, with the growing evidence before us, that electricity, in its gentle control in the hands of modern genius and its majestic terror in nature, is really the long sought element that controls the more subtle movements of attenuated matter in the depths of space?

A peculiar relation of the higher activities pervading the solar system, perhaps the universe, is suggested by M. Duponchel in France, who calls attention to the actual facts of science in regard to the nature of electricity, magnetism, light, and heat, as not only convertible terms, but as testifying to the absolute conservatism of the living force of motion; that these elements, which are emitted, return to the focus of departure, forming a close circuit of continuous circulation analogous to that of the blood.

The evidence is fast pressing upon us, the acknowledgment that our earth is enveloped with an electric non-gravitating element mingled with our compound atmosphere in intensity inversely as its density; making its manifestations with terrific force and perplexing reversions of polarity, as noticed by observers at high altitudes and particularly observed recently at Pike's Peak.

By experiments that we are more or less familiar with, it is manifest that electricity develops its greatest activity when in contact with ponderable matter of the least density. That in the best vacuum that we are able to produce, it becomes self-luminous; while in the attenuation of the confines of our atmosphere its manifestations are at times so vivid that we cannot but regard it as a fundamental element that in a measure controls the activity of matter of low tension, its motion and its luminosity.

Therefore, may we not venture to assign to it the properties of being the mysterious and long sought connecting link of our solar system, possibly the leading string of the universe?

* Paper read before the American Astronomical Society, Feb. 4, 1884.

ACTION OF OZONE ON ANTHRACENE AND ALIZARINE.

FILTER paper is saturated with a hot solution of anthracene in ether and dried, then exposed over phosphorus or in any atmosphere containing ozone, for a day, and then boiled with zinc dust and caustic soda, and rapidly filtered; the filtrate will have a red color, and will give a yellowish white precipitate. This reaction shows that the anthracene has been converted into anthraquinone.

Paper saturated with hydrochlorate of aniline acquires a red color in air ozonized by electricity, but turns brown if the ozone is formed by moist phosphorus.

In like manner, paper soaked in an alcoholic solution of diphenylamine shows a distinction between electric oxygen and that which has been ozonized by phosphorus, for the former turns it at once light brown, the latter colors it lemon and orange yellow at first.

Finally, if the sulpho-acid is prepared, according to Wagner, by dissolving diphenylamine in warm sulphuric acid, and electric sparks are passed through the air of the vessel containing it, it will be colored deep blue for a short time by the ozone.—*Zeitschrift fur Anal. Chemie.*

[Much doubt still exists as to whether phosphorus is able to produce true ozone, which doubt is strengthened by these reactions.]

CHEMICAL DIALYSIS WITH ETHER OR CHLOROFORM WATER.

H. STRUVE recently read a paper before the St. Petersburg Academy of Science upon the use of dialysis in chemical analysis, etc. The results obtained by dialysis do not always correspond to the results expected, which he attributed to three causes: 1. The substances examined decompose so easily. 2. The use of parchment paper instead of animal membranes. 3. The difficulty of examining the substances separated in the dialyzer.

To avoid and overcome these difficulties the author makes use of chloroform water, made by shaking the water with an excess of chloroform and letting it settle, or of ether for the outer liquid. Chloroform water has remarkable antiseptic properties, and offers an excellent medium for subjecting organic matter to a complete leaching process, without any fear of decomposition setting in, if care is taken to have it retain the chloroform odor.

He replaces the parchment paper with bladder or intestinal membrane. This is softened in water, then the fat removed as completely as possible, and washed several times with ether. It is preserved under ether, in which it will keep for years without losing its usefulness.

The author proceeds as follows: The substance to be examined is put in a bladder which is tied up with white silk, and then suspended in a stoppered vessel partially filled with chloroform water, when the dialysis begins, and can be quietly followed in all its details. The chloroform water may be renewed as often as necessary and the separate diffusions preserved.—*Chem. Zeit.*

REPORT ON GLUCOSE.

THE National Academy of Sciences, through President O. E. March, made their report on glucose to the Commissioner of Internal Revenue. The following is a summary of the report:

First.—Starch sugar as found in commerce is a mixture in varying proportions of two sugars called dextrose and maltose, and of dextrin or starch gum. Dextrose was discovered in grapes by Lowitz in 1792, and was first prepared from starch by Kirchhoff in 1811. In 1819 Braconnot prepared it from woody fiber. Maltose was first recognized as a distinct sugar by Dubremfant in 1847, in the product of the action of malt on starch. No dextrose is thus produced, according to O'Sullivan.

Second.—The process of making starch sugar consists, first, in separating the starch from the corn by soaking, grinding, straining, and settling; and second in converting the starch into sugar by the action of dilute sulphuric acid, this acid being subsequently removed by the action of chalk. To make the solid "grape sugar" the conversion is carried further than to make liquid "glucose." After clarifying, the liquid is concentrated in vacuum pans and is decolorized with bone black.

Third.—The starch sugar industry in the United States gives employment to twenty-nine factories, having an estimated capital of $5,000,000, consuming about 40,000 bushels of corn per day, and producing grape sugar and glucose to the annual value of nearly $10,000,000. In Germany in 1881-82 there were 39 factories of this sort, consuming over 70,000 tons of starch and producing about 40,000 tons of starch sugar.

Fourth.—Starch sugar is chiefly used in making table sirup, in brewing beer as substitute for malt, and in adulterating cane sugar. It is also used to replace cane sugar in confectionery, in canning fruits, in making fruit jellies, and in cooking. Artificial honey is made with it, and so also is vinegar.

Fifth.—Starch sugar represents one distinct class of sugar, as cane sugar does the other, the former being obtained naturally from the grape, as the latter is from the cane and the beet. Starch sugar, which is a term chemically synonymous with dextrose and glucose, when pure has about two-thirds the sweetening power of sugar-cane. By the action of the dilute acids both cane sugar and starch yield dextrose. In the case of starch, however, dextrose constitutes the sole final product.

Sixth.—The commercial samples of starch sugar obtained by the committee showed a fairly uniform composition on analysis. The liquid form, or "glucose," contained from 34·3 to 42·8 per cent. of dextrose, from 0 to 19·3 per cent. of maltose, from 29·8 to 45·3 per cent. of dextrine, and from 14·2 to 22·6 per cent. of water. The solid form, "grape sugar," gave from 72 to 73·4 per cent. of dextrose, from 0 to 36 per cent. of maltose, from 4·3 to 9·1 per cent. of dextrine, and from 14 to 17·6 per cent. of water. Three specimens of especially prepared "grape sugar" contained 87·1, 93·2, and 99·4 per cent. of dextrose respectively. The last of these was crystalline anhydrous dextrose.

Seventh.—Of mineral or inorganic constituents, the samples of starch sugar examined contained only minute quantities. The total ash formed in the "glucose" was only from 0·325 to 1·000 per cent., and in the "grape sugars" only from 0·335 to 0·750 per cent. No impurities, either organic or inorganic in character, other than those mentioned, were detected in any of the samples examined.

In conclusion, then, the following facts appear as the result of the present investigation:

First.—That the manufacture of sugar from starch is a long established industry, scientifically valuable and commercially important.

Second.—That the processes which it employs at the present time are unobjectionable in their character, and leave the product uncontaminated.

Third.—That starch sugar thus made and sent into commerce is of exceptionable purity and uniformity of composition, and contains no injurious substances; and

Fourth.—That though having at best only about two-thirds the sweetening power of cane sugar, yet starch sugar is in no way inferior to cane sugar in healthfulness, there being no evidence before the committee that maize starch sugar, either in its normal condition or fermented, has any deleterious effect upon the system, even when taken in large quantities.

The report is signed by George F. Barker, chairman; William H. Brewer, Charles F. Chandler, Wolcott Gibbs, and Ira Remsen.

THE FORMATION OF SULPHURIC ACID IN THE LEAD CHAMBERS.

PROFESSOR G. LUNGE, the great authority on the manufacture of sulphuric acid, has read a paper before the Helvetic Society on the formation of sulphuric acid in the lead chambers, basing his conclusions upon results obtained by M. Naef, of the Metiken Works. His conclusions are the following:

1. In the ordinary course of working, no hyponitric acid exists in the lead chambers. This acid takes no part in the formation of sulphuric acid. It arises merely as a secondary product, and under quite peculiar circumstances.

2. In presence of a large excess of nitrous gases, the formation of N_2O_4 takes place in the last chamber, and in this there is very little sulphuric acid produced. It seems very probable that the absence or the reflux of sulphurous acid is of great importance for the production of N_2O_4.

3. The quantity of oxygen contained in the gas of the chambers has little influence on the formation of N_2O_4.

4. If the gaseous current in the chambers is yellow, the loss in N_2O_3 and N_2O_4 in the Gay-Lussac tower is of a certain importance, and under ordinary circumstances may rise to 60 per cent. of the total loss.

5. If the gaseous current is colorless, the loss in nitrate in the Gay-Lussac tower is equal to 0·5 per cent. of niter, or to 20 per cent. of the entire loss. The gases which escape contain mere traces of N_2O_3 and N_2O_4, but, instead, NO and SO_2.

6. We never find N_2O_4 in the tower acid, even when the gases of the chambers and the escaping gases contain it.

7. During the transformation of SO_2 into H_2SO_4 there occurs an anomaly which is not without interest. As far as to the center of the first chamber, 75 per cent. of the total quantity of sulphurous anhydride are transformed into sulphuric acid; from there to the end of the chamber, only 4 per cent. more of SO_2 are converted. The total quantity of SO_2 is further lessened by 10 per cent. after the gases have traversed the connecting pipe between the first and the second chamber. The employment of a system of several chambers is very favorable to the good working of the plant; for in passing from one chamber to another the gases undergo a slight compression in the pipes, and are mixed in an intimate manner.

8. In the center of the first chamber the mixture of gases is almost complete. The composition of the gaseous mixture is the same at different heights. At the center there is from 0·1 to 0·2 per cent. more SO_2 than along the sides.

9. It is improbable that the gases which penetrate into the chambers rise at first, and afterward slowly redescend. They become quickly mixed already in the anterior portion of the first chamber.

10. The progress of the temperature in an entire system of chambers is very regular. In the first fourth part of the first chamber, where the chemical reactions are very intense, the temperature of the gases rises about 5 degrees to 6 degrees, and then falls slowly. Toward the end of the series of chambers, the fall of temperature is a little stronger.

11. On increasing the cubic measurement of the chambers from 1·5 to 1·8 meters per 3 kilos. of sulphur burnt in the first two chambers, there is observed a decrease of temperature of from 9 degrees to 10 degrees, and in the third of from 5 degrees to 6 degrees.

12. The reduction of temperature by the sides of the chambers is scarcely perceptible in the interior beyond the distance of 25 centimeters from the side, the ambient temperature being 19 degrees. At from 5 to 10 centimeters from the side, the reduction of temperature is 2 degrees, and at from 10 to 25 centimeters only 1 degree. From the distance of 25 centimeters from the wall to the middle of the chamber, the difference of temperature is 5 degrees, and from the side to the center 8 degrees.

13. In the middle of the first chamber, the temperature is lower by 5 degrees at the bottom than at the top.

14. The use of the atomized water instead of steam has no great influence upon the temperature of the chambers.

ON THE TEMPERATURE OBTAINED BY OXYGEN IN EBULLITION, AND ON THE SOLIDIFICATION OF NITROGEN.

By M. S. WROBLEWSKI.

OF all the gases formerly considered as permanent, hydrogen is the only one which has failed to give, at a temperatured of —136° C., any sign of liquefaction. Not even is there any cloud produced in the tube containing it if the gas at this temperature, compressed to 150 atmospheres, 2250 lb. per sq in., is suddenly released. To liquefy hydrogen we must evidently have recourse to a lower temperature than the lowest obtained by liquid ethylene allowed to boil in a vacuum. Among the gases which are more difficultly liquefiable than ethylene, and therefore suitable for the production of a much more intense cold, oxygen has appeared to me to be most easily available.

The conditions for the liquefaction of oxygen being well understood from the researches which I have had the honor to bring before the Academy, it follows that this gas can now be liquefied in considerable quantities with great ease. A thousand devices and kinds of apparatus may be imagined by which this liquefaction can be effected. Indeed, the industrial production of liquid oxygen is, I may almost say, only a question of the material means at the disposal of the experimentalist. Thus, I have employed, since the month of October last, liquid oxygen as a refrigerating agent, and I ask permission to lay before the Academy the results of my experiments.

Liquefied in large quantity, and suddenly allowed to evaporate by release of the pressure, oxygen does not solidify like carbonic acid, but it leaves a crystalline residue on the bottom of the apparatus in which it was kept in the liquid state and on the object to be cooled plunged in the oxygen. I am not able to say if this residue consists of crystals of oxygen only or if it is due to possible impurities, since the oxygen I used was prepared from a mixture of potassium chlorate and manganese peroxide. This residue disappears when the temperature begins to rise. If the body to be cooled is in a glass tube, the thin layer of this opaque residue is often very annoying for the observer.

Another circumstance which renders it very difficult to employ liquid oxygen as a refrigerating agent is the necessity of using it in closed vessels having great strength. I have not yet been able to obtain oxygen in the form of a static liquid at the normal atmospheric pressure. It has therefore been necessary to immerse the substances to be cooled in the apparatus which I fill with liquid oxygen, and I can only make use of the cold produced by the oxygen when boiling on the sudden release of the pressure. As these apparatus are partly constructed of glass great inconvenience is caused by the constant danger of serious explosions. After several accidents which have occurred during these experiments, my assistants and myself now always work with masks before our faces.

But the greatest difficulty in these experiments is the very short duration of the ebullition of liquid oxygen, and consequently the too short time of the refrigeration.

I have attempted to measure the temperature of oxygen when in a state of ebullition. For this purpose I have employed a thermo-electric method of measuring which, besides its great sensitiveness, admits of the registration of all the sudden changes of temperature of the medium. The indications of the apparatus have been compared with those of a hydrogen thermometer between +100° C. and —130° C. The nature of the function connecting these two indications permits an extrapolation being made.

Reserving the description of my method to a subsequent communication, I may here give *one hundred and eighty-six degrees below zero* (—186° C., almost —303° F.) as the first approximation to the temperature produced by the sudden release from pressure of liquefied oxygen.

I have submitted nitrogen successfully to the action of this cold. This gas compressed, cooled in boiling oxygen, and then allowed to expand a little, solidifies and falls like snow in crystals of remarkable size.—*Comptes Rendus, Dec. 31, 1883.—Chemical News.*

MICROBICIDE ACTION OF COPPER SULPHATE.

THE spores of the mucedinæ can develop in solutions of copper sulphate containing one per cent. The vibriones of putrefaction swarm in cupric solutions at one-tenth per cent. The proportion of copper necessary to arrest the development of vibriones is at least four times greater than that which proves fatal to guinea pigs, and ten times greater than that sufficient to destroy dogs. Experimental bacteræmia can be equally produced in animals whether they have undergone subcutaneous injections of copper sulphate or not. Bacteria can be developed in the blood of animals which have died from the effects of copper sulphate, whether introduced internally or subcutaneously.—*M. Rochefontaine.*

A SUBSTITUTE FOR TARTAR EMETIC.

A SUBSTANCE has appeared in the German market, especially Leipzig, which claims to be a substitute for tartar emetic. It is a handsome preparation, is very soluble, and sells at a lower price, consequently it has found quite a large sale, for it so closely resembles tartar emetic that it is impossible to distinguish the two except by analysis. Owing to its cheapness it has almost displaced the tartar, especially for dyeing and calico printing.

To ascertain exactly what it consisted of, the *Chemiker Zeitung* undertook its analysis, and soon found that it did not contain a trace of tartaric acid. Further examination showed that it was an oxalate, instead of a tartrate of potash and antimony. A quantitative analysis showed that it was identical with the salt described by Souchay and Lenssen in the *Annalen der Chemie and Pharmacie*, cv., 250, which has the formula of C_4O_{12} SbK_3+6H_2O. This salt only contains 23·67 per cent. of antimonic oxide, while tartar emetic contains 43·7 per cent., or nearly twice as much of the active constituent.

Although the new preparation is cheaper, the difference in price is not in proportion to the difference in value. The manufacturer not only saves in antimony, but by the substitution of cheap oxalic acid for the expensive tartaric acid he also makes a further saving in expense.

We have satisfied ourselves, says the *Chemiker Zeitung*, that the preparation of this "substitute" is both simple and easy. All that is needed is to make a boiling solution of binoxalate of potash and saturate it while hot with freshly precipitated oxide of antimony, and filter hot. On cooling, the salt crystallizes most beautifully, and is perfectly identical with the commercial product.

THE DECOMPOSITION OF AMMONIA BY HEAT.

A PAPER on this subject was read at the meeting of the Chemical Society on the 20th ult., by Messrs. W. Ramsay and S. Young. The results may be summed up as follows:—When ammonia gas is passed through a porcelain tube, or an iron tube, or a glass tube, fitted with asbestos cardboard, the amount of decomposition at 500° to 520° is nearly equal, and very small. Ammonia, therefore, begins to decompose a little below 500°. In contact with a glass surface, the temperature at which decomposition begins is much higher; the amount of decomposition depending on the rate of passage of the gas, and on the nature of the surface. Thus ammonia is completely decomposed by passing through a plain iron tube heated to 780°. By passing ammonia through a glass tube containing iron wire at 760°, 76 per cent. of the ammonia was decomposed; while with copper wire, under similar conditions, only 2 per cent. was decomposed.

ANOTHER DELICATE TEST FOR NITRIC ACID.

A. LONGI recommends in the *Gazzetti Chimici* the following method of testing for nitrates in solution. A few drops of paratoluidine are first added to the solution, and then sulphuric acid is poured upon it. Where the two liquids are in contact an intensely red color will be observed, which passes after a while into dark yellow. If pure toluidine is not at hand, the test can be made with crude aniline (the high boiling aniline oil used for making fuchsine always contains toluidine). The red color may be distinguished when only $\frac{1}{1000000}$ of nitric acid is present. Chlorates, chromates, and permanganates give a different color (blue) with this reagent.

SULPHATE OF IRON IN STEAM BOILERS.

IT has frequently been noticed that there would be formed upon the exterior surface of a steam boiler, a yellow deposit consisting chiefly of a sulphate of iron (ferric sulphate). Upon the occasion of a boiler explosion, Dr. R. List made an analysis of this yellow substance, and found it to be a highly basic sulphate of iron, having approximately this composition: $(Fe_2O_3)_5 SO_3$. It dissolves slowly in a small quantity of water, but if heated with much water, a reddish yellow precipitate is thrown down still more basic in composition, and the solution then contains either free sulphuric acid or an acid salt that dissolves metallic iron with an evolution of hydrogen, and this again precipitates the basic salt. As this process is repeated over and over, the boiler is more and more attacked.

This sulphate of iron may be formed on the exterior of the boiler by the action of products of combustion of coal containing sulphides, in the presence of watery vapors or steam. But within the boiler, too, free sulphuric acid or sulphates must have a bad effect, even in very small quantities, for the reason above given, and such was actually found to be the case in a new boiler. For this reason care must be taken not to put any water into the boiler that contains ever so little free sulphuric acid, nor anything that can form sulphate of iron in the boiler. If the feed water exhibits any acid reaction, it is very easy to neutralize it with a small quantity of soda.—*Poly. Notizblatt.*

HOW TO PREPARE LANTERN TRANSPARENCIES.

WE commence with the preparation of the albumen itself—say of ten ounces. This will require from a dozen to fifteen eggs, according to their size. These, if available, should by preference be "new laid," though good French eggs will answer nearly, if not quite, as well. The eggs must be broken, and the whites carefully poured away from the yolks, keeping the latter in the shells. The germs should then be separated. To ten ounces of the albumen half a drachm of glacial acetic acid in half an ounce of water is added, and the whole intimately mixed by stirring with a glass rod. No attempt should be made to cause it to froth, which if done would give rise to trouble. Half a minute's stirring is all that is necessary. The acid will produce a precipitate, and render the albumen exceedingly limpid. After standing a few hours it is passed, first through a piece of muslin to remove the coagulum, and afterward filtered through a piece of sponge plugged in the neck of a funnel. After filtration forty minims of ammonia, 0·880, is added, which causes the albumen to regain much of the viscosity the acid had destroyed. Albumen thus prepared will keep quite good for many months, if preserved in well-corked bottles. This method of preparing the albumen, if our memory serve us correctly, was first published by Mr. William Ackland.

For use, the albumen is iodized by adding one drachm of iodide of ammonium dissolved in half an ounce of water; sometimes ten or twelve grains of bromide are also added. The albumen being ready, we proceed to coat the plates. For this purpose some old iodized collodion is required. Any commercial sample that has been iodized for a length

of time will answer, provided it yield an even and structureless film. If it be very old it will possibly give a thin and tender film, in which case a little fresh pyroxyline must be added to give it body.

The glass plates being thoroughly cleaned and ready to hand, one is taken and coated with the collodion. After this has been allowed to set, the plate is immersed in a dish of common water, where it is allowed to remain, with occasional agitation, until all greasiness has disappeared. It is then rinsed under the tap and placed standing on a pad of blotting-paper to drain, while another plate is being collodionized. Now take the drained plate and pour over it, beginning at one end, a little of the iodized albumen. Flow it over in a wave, so as to carry the superfluous water before it, which, with the albumen, should be allowed to run off into the sink. Drain the plate somewhat closely and apply a second lot of albumen, avoiding air-bubbles, and keep it in motion on the plate for half a minute or so in order that the albumen may penetrate into the collodion film. Then pour off into a measure, and stand the plates in a rack to drain. The second lot of albumen from one plate will do for the first application to the next, and so on. By this means the albumen will be economized.

After a dozen plates have been coated, take the first one and hold it in front of a clear fire until it is dry, and so, in turn, with the remainder. When the plates are dry it is a good plan to make them as hot as the hand can bear, for this treatment will prevent the films from blistering in the after operations, which, otherwise, they may have a tendency to do with some samples of collodion. Instead of drying the plates by the fire some prefer to allow them to dry spontaneously; but, in this case, it will be found a good plan to make them thoroughly hot, for the reason just mentioned. Plates thus prepared will keep for years if preserved in a dry place. It need scarcely be mentioned that all these operations may be performed in open daylight.

We shall now proceed to the sensitizing of the plates.

The formula for the bath stands thus:

Nitrate of silver	2	ounces.
Distilled water	1	pint.
Iodide of potassium	5	grains.
Glacial acetic acid (52°)	2½	ounces.

The method of mixing is as follows: First, the iodide is dissolved in the water, then the nitrate of silver is added, and the whole well stirred with a glass rod until the silver is dissolved. The solution is then filtered, and, finally, the acetic acid is added, when the bath is ready for use. The object of adding the iodide is to saturate the bath with iodide of silver in order to prevent any of that salt being dissolved out of the film after it is once formed, which otherwise might happen. Sufficient of the solution to cover the size of the plate to be sensitized is poured into an ordinary dipping bath. The plates are then immersed (with the precautions usual in the wet collodion process) for a period of half a minute to a minute only. In summer, when the solution is warm, thirty seconds will be ample, and in winter the longer time may be allowed; but it should never be exceeded, as the sensitizing is very rapid, and a longer time than is necessary will affect the plate injuriously.

By continual use the bath will become discolored, as does that employed for sensitizing albumenized paper. It may, however, be decolorized by simply shaking it up with a little kaolin. If the bath be much used—or if it be allowed to stand in an open vessel when out of use—the addition of a small quantity of acetic acid from time to time will be necessary. Some operators prefer to employ a new solution for each batch of plates. In this case the plates are usually sensitized in a flat dish, when, of course, a much smaller quantity of solution will suffice. When the plates are taken from the bath, they are placed in a dish of distilled water to remove the major portion of the free nitrate, after which they are thoroughly washed under the tap to eliminate the remainder. They are then reared up on a pad of blotting-paper to drain, and are afterward dried.

The drying may be accomplished in any of the boxes used for gelatine plates, and, as the film is very thin, it does not retain much moisture; therefore the plates dry very much quicker than do gelatine. As many who do not possess properly-constructed drying boxes or cupboards may like to try the albumen process, it may be mentioned that one, suitable for the purpose, may be extemporized by taking an ordinary box or packing case and placing it in front of the fire for an hour or so to thoroughly desiccate the wood. In this the plates are placed on some dry blotting-paper, and in a few hours the plates will be perfectly dry, the moisture from them having been absorbed by the desiccated wood. We have ere now used a common hat box when anything more suitable was not at hand. It may be as well to mention here, for the information of those who have never prepared albumen plates, that it must not be expected that the films will be dense and creamy like those of gelatine, or even of wet collodion, as they are always very thin and transparent.

Printing the transparencies may be effected either in the camera or by superposition, the latter being the method usually followed; but if the negatives be a different size to that of the required slide the camera must not be used, and with it a lens capable of giving good definition with a large aperture. For compared with wet collodion the albumen process is slow, and in comparison with gelatine *very* slow indeed, although it is not so slow as the gelatine chloride process. With the camera the exposure will necessarily be somewhat long, and, as a rule, when prolonged exposures are given, the color of the image is rarely satisfactory.

In printing by superposition, either diffused daylight or artificial light—such as a gas flame or a paraffine lamp—may be employed. With regard to the time of exposure little can be said, as all will be dependent upon the source of light employed, the distance the plate is placed from it, as well as upon the density of the negative itself. Therefore, the experimentalist must determine this matter for himself. This he can easily do by exposing a plate or two under a negative of average intensity, giving different times for different portions of it, and then developing. One or two plates exposed in this way will enable a very correct judgment to be formed as to the exposure required in future for every class of negative. When once this is arrived at it remains constant, because, unlike the gelatine, each batch of albumen plates prepared may be relied upon as being of equal sensibility.

We now come to the development of the image. This at one period was treated, and preserved, as a great secret. The developing solution after all is very similar to that used in the wet-collodion process before the iron developer was introduced, except that it contains a little citric acid, and that *it is employed warm*. A good developer is as follows:

Pyrogallic acid	25	grains.
Glacial acetic acid	½	ounce.
Citric acid	10	grains.
Water	10	ounces.

This solution had better be made and kept in a Florence flask, so that it can be heated and kept warm over a spirit lamp when required for use.

The exposed plate is first placed in a dish of distilled water, heated to about 150° F., until it has acquired that temperature. It is then removed, slightly drained, and flooded with the developing solution, which has previously been heated to about 130° or 140° F. Immediately before the solution is applied it must have about four drops, per ounce, of a five-grain solution of nitrate of silver added. If properly exposed the image will quickly appear, and by the way it comes out it may be judged if the exposure has been rightly timed or not, similarly as in the development of plates by any other process. As the films are so very thin and transparent, the density of the image can easily be judged of by transmitted light. It is always best to err on the side of under than over density, because, in the latter case, the slides will always appear dense and heavy on the screen; whereas if they be slightly thin it may, to some extent, be remedied in the toning. As a guide in the development, it may be borne in mind that the more fully the plates are exposed and the more rapidly they are developed, as also the less silver employed in the developer, the warmer will be the color of the image; while the slower the development, either from the solution being cold or the plate under exposed, or if too much silver be used, the more the picture will approach an olive-brown tone.

As the development proceeds, the plate must be carefully watched for stains or fog. If any appear the plate must at once be washed under the tap, and the surface rubbed with a pledget of cotton wool, which will remove them. The development can then be recommenced with a fresh batch of solution and silver, repeating the treatment with the cotton wool if found necessary. When the development is complete, the plate must be thoroughly washed under the tap to remove all traces of the pyrogallic acid, which, if allowed to remain, would tend to injure the toning bath.

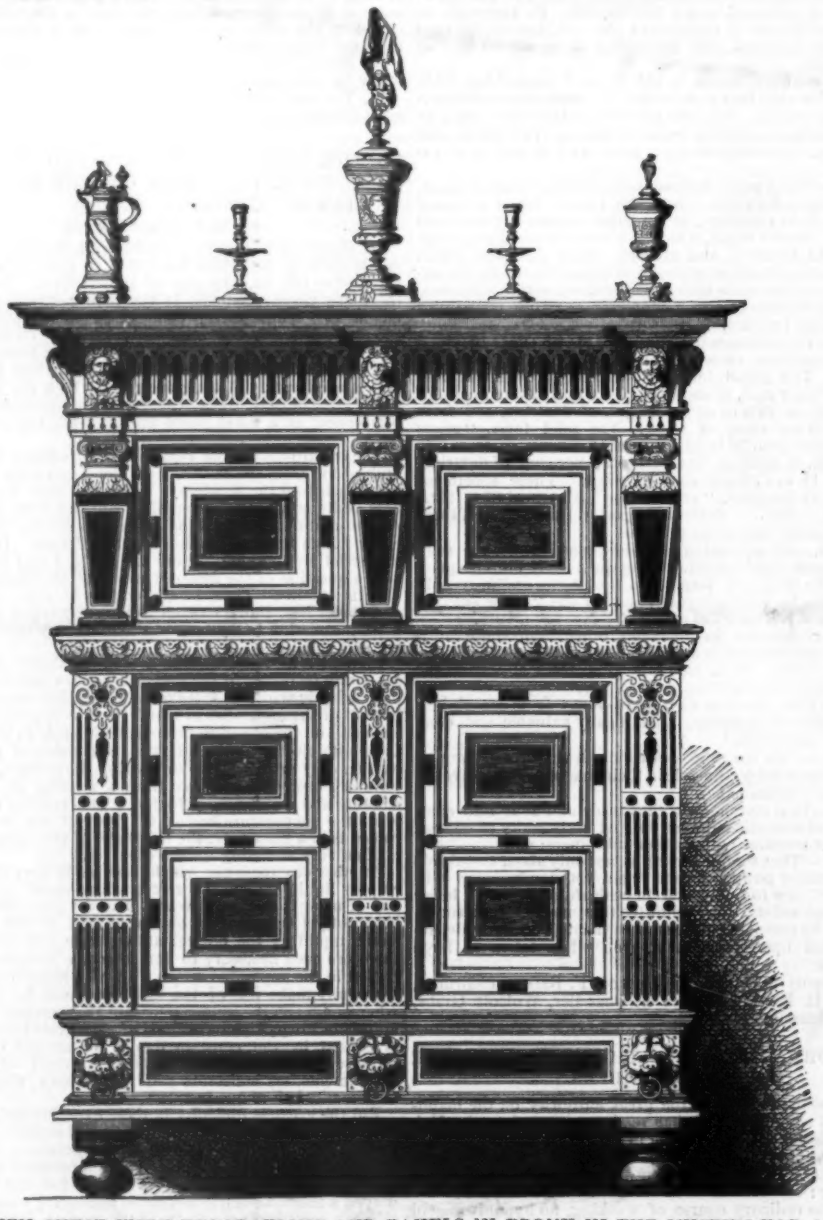
The plate is now ready for fixing and toning. This is usually done in one bath, which is made as follows: Half a pound of hyposulphite of soda is dissolved in half a pint of water; then three grains of chloride of gold, dissolved in two ounces of water, are added very gradually, and with vigorous stirring. After standing twelve hours and being filtered it is ready for use. It is then placed in a flat dish, and the plate immersed. The iodide is quickly dissolved out, but the toning proceeds slowly—from a quarter to half an hour or more being frequently required to obtain deep, rich tones. But much depends upon the color and density of the image at starting. When the desired tone is obtained the plate is well washed under the tap and afterward soaked in plenty of water, and again rinsed to insure the entire removal of all traces of the hypo. Indeed, as much care should be bestowed on this part of the operation as in the case of gelatine negatives, in order to insure permanency.

Alkaline gold toning (after fixing in plain hyposulphite and thoroughly washing) may be employed instead of the double fixing and toning bath; but the color obtained in our hands and to our taste has not been so satisfactory as by the method just described, which is that used by MM. Ferrier and Soulier.—*British Journal of Photography.*

THE MONUMENT TO GENERAL A. VON GOEBEN, COBLENTZ, GERMANY.

THE annexed cut, taken from the *Illustrirte Zeitung*, represents the monument erected on the grave of Gen. A. Von Goeben, formerly commander of the 8th corps of the German army. The monument was designed and executed by Mr. H. Epler of Dresden, a scholar of the well known sculptor Johannes Schilling.

The winged female figure, representing the Goddess of Victory, is seated on the grave of the dead soldier. She is represented as breaking off a branch of laurel with her right hand to complete the wreath held in her left hand. A band wound on the wreath bears the names of Spain, Denmark, France, the Main Campaign, and St. Onentine, at which place a decisive battle was fought in which Gen. Von Goeben participated.



OAK LINEN CHEST WITH DECORATIONS AND PANELS IN EBONY IN THE MUSEUM FOR ART AND INDUSTRY, HAMBURGH. NETHERLANDISH WORK OF THE SEVENTEENTH CENTURY FROM A FARM HOUSE OF ZOLLENSPIEKER. ONE-TENTH OF ACTUAL SIZE. THE ARTICLES ON THE CHEST ARE BRASS CANDELABRA AND TIN VESSELS OF THE SEVENTEENTH CENTURY.—*The Workshop*

The expression of the face of the Goddes, which is earnest and pensive, indicates quiet and rest, and it is this feature which adds greatly to the beauty of the figure.

The figure is slightly larger than life size, and is made of a single block of Carrara marble. The pedestal consists of a block of Swedish granite resting on a base which covers the entire grave.

THE TREATMENT OF BOILS AND CARBUNCLES.

THE *London Med. Record*, December 15, 1883, tells us that Dr. Rupprecht, of Hettstadt (*Deutsche Med. Wochensch.*, May 29), regards furuncles, carbuncles, and anthrax pustules to be all dependent on an infectious cause, and the same treatment to be suitable for all of them. In boils he removes the little scab which always forms early on the top, and presses into the purulent cavity a little piece of cotton-wool moistened with spirit of ammonia. This ought to be done six or eight times at a sitting, a fresh piece of wool being used each time, and it may be necessary to repeat the treatment on the following day. In very large boils scarification, and in carbuncles a cross incision, must precede the application of the ammonia; in anthrax, the scab must be removed, and the surrounding tissue scarified in a radiating

THE MONUMENT OF GENERAL v. GOEBEN, KOBLENZ, PRUSSIA.

form. The part should be dressed with boracic ointment after this cauterization, and it generally heals without causing any disturbance. Boils in the external ear, where septic material is easily conveyed by the fingers, should be incised with a very small knife, and then dressed with some antiseptic which will not injure the tympanum, such as thymol, boracic acid, or iodoform.

THOMAS HOLLOWAY.

MR. THOMAS HOLLOWAY, the well-known manufacturer of patent medicines, died of bronchitis, at his residence, Tittenhurst, near Sunningdale, Berks, on Dec. 25, 1883, at the advanced age of eighty-four. His name will long be remembered for the munificence which he showed in the closing years of his life. In 1873 he put aside a quarter of a million sterling to erect, for the use of the middle classes, an asylum for the insane, called the Sanatorium, at St. Ann's Hill, near Virgina Water, and he subsequently bestowed a very large additional sum of money upon its completion and endowment.

A few years later he gave another quarter of a million, and promised £100,000 additional for endowment, for a building to be called the Holloway College for the Higher Education of Women. The first brick of this building was laid in September, 1879, at Mount Lee, Egham, and its erection has since been proceeded with. It is intended to be a memorial of Mr. Holloway's wife, who died some years ago. The governors of the college are twenty-one persons, to be appointed partly by the University of London, partly by the Corporation of London and the Corporations of Windsor and Reading. It is stipulated that a certain number of the governors shall always be women. Religious opinions are not in any way to affect the qualification for a governor. It is the founder's desire that power by Act of Parliament, Royal charter, or otherwise, should be eventually sought to enable the college to confer degrees, after due examination; but that until such power is obtained the students shall qualify themselves to pass the Women's Examination of the London University, or any examination open to women at any of the existing universities of the United Kingdom. But the governors will be empowered to provide instruction in any subject or branch of knowledge which shall appear to them, from time to time, most suitable for the education of women. Proficiency in classics is not to entitle students to rewards above those equally proficient in other branches of knowledge. It is intended to provide twenty founder's scholarships, of the value of £40 each, tenable for not more than two years in the college. No professor will be required to submit to any test concerning his or her religious opinion. Students will have the right to attend the services of the Church of England, or of any sect or denomination which their parents or guardians may desire. The domestic life of the college is to be that of "an orderly Christian household," with a daily simple service, the reading of a portion of Scripture, and a form of prayer approved by the governors. The principal of the college will be a lady, and duly qualified lady physicians and surgeons are to be resident in the college. Every student will have a separate bed-room and sitting-room; and there will be accommodation for two hundred and fifty. The building, designed by Mr. W. H. Crossland, architect of the Holloway Sanatorium, is a noble edifice, in the French Renaissance style, comprising two large quadrangles, with internal arcades or cloisters, and contains a thousand rooms, a chapel, library, museum, picture gallery, music-room, and dining-hall, of fine proportions and handsomely decorated. Mr. Holloway, who was a great picture-buyer, has given to the College a collection of works of art valued at £90,000. The endowments of the College and the Sanatorium are committed to the charge of trustees—Mr. George Martin and Mr. Henry Driver, the brothers-in-law of Mr. Holloway.

The Holloway Sanatorium, which has cost, including the endowments, about £350,000, is to be partly self-supporting. It is for the reception, during twelve months and no longer, of curable cases of mental disease, and is intended for patients of the middle class, such as professional men, clerks, teachers, and governesses, as those of the lower working class are provided for in the public asylums. There is accommodation for four hundred patients, male and female. We present an illustration of the building, which stands on a rising ground in pleasure-grounds of twenty-two acres extent, close to the Virginia Water station of the London and South-Western Railway. It is of red brick, dressed with stone, with a lofty tower, and with a front designed by the architect, Mr. W. H. Crossland, in the English Renaissance style. The interior decorations have been designed and executed by various hands, under the direction of Mr. George Martin; and it is considered that the sight of them may have a distinctly beneficial effect on the minds of the patients. With the exception of the massive gray marble top of the balustrade, the whole of the entrance-hall and of the staircase is painted and gilt with figures and patterns, arabesque and grotesque, which are of immense variety, and are really beautiful, as well as cheerful and ingenious. The entertainment or recreation hall is remarkable for a splendid gilded

THE LATE MR. THOMAS HOLLOWAY.

roof, and for a profusion of gilding and other decorative work on the walls and behind the platform. Portraits of distinguished persons by Mr. Girardot and other artists form part of the decoration scheme, and add interest to it. In the refectory, which is a very fine apartment, the adornments consist of a series of paintings in the style of Watteau, forming a frieze, above which are smaller groups in lunettes. In the smaller parlors and living rooms the same purpose of attractiveness and suggestiveness is carried out. All the internal arrangements are admirably planned, as well for maintaining general health as for isolating special cases of disease, for providing that attendants shall unobtrusively live close to the patients confided to their charge, and for conveying an idea of freedom combined with active surveillance. The kitchen is most skillfully contrived and fitted up for cooking food for five hundred or more persons at once. To make all complete, there is a model laundry in an entirely separate building, and pretty red brick houses have been built for such of the staff of the establishment as are not obliged to sleep in the main building. There is a separate building for a chapel. The pleasure-grounds are planted with thousands of young trees and shrubs, and there are gardens, with a terrace on which patients may enjoy the sunshine and pure air.—*Illustrated London News.*

CHARCOAL.

ABOUT twenty-five years ago Dr. Belloc, a retired French officer, turned his attention to charcoal as a remedy for dyspepsia. He was himself a sufferer, and had thus an opportunity of testing its action. He decided after many trials that charcoal made from poplar wood is the best. He found that the charcoal of some other woods caused a disagreeable taste in the mouth—even painful excoriations of the mucous membrane—thirst, and a pinching sensation at the pit of the stomach. He was in the habit of prescribing from two to six spoonfuls, but says he has himself taken as much as 500 grammes—more than fifteen ounces—in a day.

The Academie Nationale de Médicine reported very favorably on a memoir Dr. B. published on the use of charcoal, and in France it soon became a favorite remedy. Its reputation spread to this country, and now we find charcoal lozenges and charcoal biscuits sold as dyspeptic remedies.* Dr. Belloc advises that it should be taken in the form of powder stirred up in water. In this country charcoal is occasionally prescribed in mixtures. The biscuits and lozenges must of course be thoroughly impregnated with saliva to enable them to be swallowed. Dr. Arthur Leared says: Give the ordinary wood charcoal freshly prepared and hermetically sealed in gelatine capsules. Three or four capsules are sufficient to give complete relief.

The power of absorbing effluvia possessed by charcoal had been known for ages, but its action upon different gases was first tested toward the close of the last century by M. Lowitz. The subject was pursued by Count Morozzo. He used box-wood charcoal exclusively in his experiments, and found that a single volume of it absorbed the gases, which possess a present interest, in the following proportions:

Sulphureted hydrogen	55
Carbonic acid	35
Oxygen	9·2
Nitrogen	7·5
Carbureted hydrogen	5
Hydrogen	1·7

The able researches of Dr. Stenhouse, published in 1855, greatly increased the interest in the subject. His experiments were mainly directed to the deodorizing properties of charcoal, and he proved beyond question that its properties of destroying the smell of putrid animal or vegetable bodies depended, not, as had been previously supposed, on its antiseptic power, but on the opposite quality of absorbing and oxidizing effluvia. Mr. Hunter has published an account of his experiments,† showing the relative amount of various gases taken up by different kinds of charcoal.

He found that charcoal made from cocoanut shells possessed most power, and deduced a general rule that the charcoal made from the harder woods was much superior to that from the softer. It may be stated that animal charcoal, so useful as a decolorizing agent, is very inferior as an absorbent.

Charcoal newly made is superior to that which has been reignited. The absorbent power of charcoal is slightly weakened by pulverization and is much impaired by exposure to the atmosphere and damp.

Charcoal, to be effective against gastric flatulence, must be introduced among the gases of the stomach in the same state as when fresh from the crucible. The means of effecting this is by inclosure in gelatine capsules.

Charcoal, by virtue of its porous nature, takes up gases mechanically, as a sponge takes up water. Its capacity in this respect is in proportion to the number and fineness of its pores. Made from vegetable ivory or cocoanut shell it is a compact, heavy substance, having a metallic luster and ring, the pores being quite invisible. Charcoal made from the most solid vegetable substances is greatly superior as a gas absorbent to that made from the lighter kinds, like Belloc's preparation; and that made from vegetable ivory is the best.

It always contains oxygen, because when taken from the crucible it immediately obtains it from the atmosphere, and

*Its qualities are lauded in an essay by Mr. Bell, "On Vegetable Charcoal: Its Medicinal and Economic Properties." Churchill, 1857.

†*Philosophical Magazine*, 1805.

THE HOLLOWAY SANATORIUM FOR MENTAL DISEASE, AT VIRGINIA WATER.

its affinity for nitrogen is much less. It has a different point of saturation for every gas; but when filled with one or more it is still capable of absorbing other gases. Thus coarse-grained charcoal saturated with ammonia takes up more carbonic acid than charcoal without ammonia, and the same charcoal when saturated with both takes up a larger quantity of sulphureted hydrogen than of either. This is a valuable property where, as in the case of the intestinal cavity, the gases are various.

Much is still to be learned on this head; but the reason why charcoal saturated with ammonia takes up carbonic acid so freely is plainly due to the formation of carbonate of ammonia.

The impregnation of charcoal with oxygen has important therapeutic actions. It is this which renders it so valuable an agent in destroying the fœtor of foul sores, and, when taken internally, in correcting any putrefactive tendencies, and it is also by virtue of this that sulphureted hydrogen is not only absorbed but immediately decomposed.

Dr. Arthur Leared adds that the beneficial action of charcoal need not be confined to the human subject, and suggests its use for flatulence in horses, and also as a remedy for that frequently fatal distention of the first stomach from carbonic acid, which occurs in cows after certain food, such as clover and potatoes.

SEVERE AND EXTENSIVE INJURY OF FOREARM, WITH RECOVERY.

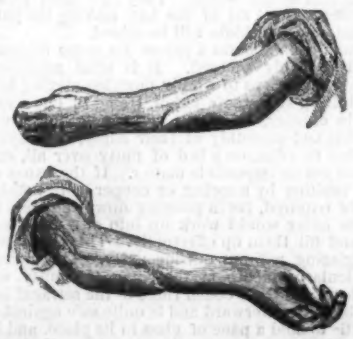
By MEIGS CASE, M.D., Washington, D. C.

THE extension of the railway system and corporate neglect to provide substitutes for hand coupling have already created an army of men, who, with absent and crippled fingers, hands, and arms, are silent witnesses of the hardships of an indispensable vocation. A statistical exhibit of the number and character of these injuries would be interesting and valuable. The unpromising appearance of these cases usually suggests amputation, and it is believed that the undefined limitations of surgical enterprise too often permit it.

The illustration shows one of these injuries, as it was presented for treatment:

Thomas Lane, twenty-eight years of age, engaged in coupling a locomotive to a "gondola," was caught by the heavy iron bar, which was driven through his left arm, fracturing both radius and ulna, about one and one-half inches in front of the elbow-joint. An additional fracture of the radius in its middle third completely detached a four-inch piece, which lay transversely across the wound. Two other small pieces of loose comminuted bone were removed. The soft parts were crushed through near the radial attachment of the biceps, and nothing remained unsevered but a few fibers of the supinator longus and the extensor radialis longior. The weight of the forearm, thrown upon these thin attachments and a band of skin less than two inches wide, permitted the most extraordinary downward displacement of the nearly severed arm. The patient said that he feared it would "drop off" before he got home. The median nerve was torn half across the ulnar artery, and the soft parts adjacent were crushed, and the wound filled with soot. The borders of the wound were twenty-three inches in length, and extended nearly around the arm, terminating at points opposite and not to exceed two and one-half inches apart. The brachio radial artery was, however, uninjured, and he had a good pulse at the wrist.

I determined at once to give the patient the benefit of this fortunate circumstance, removed portions of crushed tissue, and carefully replaced the parts, and secured them by interrupted sutures. The whole was held in position by lateral splints of flannel and plaster of Paris, and the whole arm laid upon a pillow and covered with yeast poultices.



The venous hemorrhage was considerable during the first two days, and extensive swelling occurred with *sloughing* of the injured muscular tissue and bulging of the under lips of the wound. By the free use of nitric acid, this process was facilitated and controlled. There was no sloughing of the skin, and union by first intention took place in nearly one-third of the suture. At the expiration of ten days, the sloughs having disappeared, and the swelling greatly diminished, drainage-tubes were inserted from bottom to top, running through the center of the arm. An opening was made for this purpose on the lower side, about three inches in front of the olecranon, and the entire arm surrounded by plaster of Paris bandage, with the exception of a half inch opening for the drainage tubes at the most dependent part.

The patient began to go about, and at the expiration of three months recovered, with some paralysis of the forearm and anchylosis of the elbow-joint; but he is able to carry a pail of water or handle a shovel and hoe as well as ever. The anchylosis at the elbow is slight, and could be easily broken up and motion restored.

The above illustration is taken from a photograph, and was made by direction of Dr. D. L. Huntington, Acting Surgeon-General of the United States, who has kindly suggested this publication.—*Medical Record.*

A LONG SLEEP.

A CERTAIN famous historical desert snail was brought from Egypt to England as a conchological specimen in the year 1846. This particular mollusk (the only one of his race, probably, who ever attained to individual distinction) at the time of his arrival in London was really alive and vigorous, but as the authorities of the British Museum, to whose tender care he was consigned, were ignorant of this important fact in his economy, he was gummed, mouth downward, on to a piece of cardboard, and duly labeled and dated with scientific accuracy, "*Helix desertorum*, March 25, 1846." Being a snail of a retiring and contented disposition, however, accustomed to long droughts and corresponding naps in his native sand-wastes, our mollusk thereupon simply curled himself up into the topmost recesses of his own whorls, and went placidly to sleep in perfect contentment for an unlimited period. Every conchologist takes it for granted, of course, that the shells which he receives from foreign parts have had their inhabitants properly boiled and extracted before being exported; for it is only the mere outer shell or skeleton of the animal that we preserve in our cabinets, leaving the actual flesh and muscles of the creature himself to wither unobserved upon its native shores. At the British Museum the desert snail might have snoozed away his inglorious existence unsuspected but for a happy accident which attracted public attention to his remarkable case in a most extraordinary manner. On March 7, 1850, nearly four years later, it was casually observed that the card on which he reposed was slightly discolored; and this discovery led to the suspicion that perhaps a living animal might be temporarily immured within that papery tomb. The museum authorities accordingly ordered our friend a warm bath (who shall say hereafter that science is unfeeling!) upon which the grateful snail, waking up at the touch of the familiar moisture, put his head cautiously out of his shell, walked up to the top of the basin, and began to take a cursory survey of British institutions with his four eye-bearing tentacles. So strange a recovery from a long torpid condition, only equaled by that of the seven sleepers of Ephesus, deserved an exceptional amount of scientific recognition. The desert snail at once awoke and found himself famous. Nay, he actually sat for his portrait to an eminent zoological artist, Mr. Waterhouse, and a wood-cut from the sketch thus procured, with a history of his life and adventures, may be found even unto this day in Dr. Woodward's "Manual of the Mollusca," to witness if I lie.—*The Cornhill Magazine.*

THE COBRA AND MONGOOSE.

By DR. G. ARCHIE STOCKWELL.

THE popular conceptions regarding those inveterate foes, the cobra and mongoose, are usually far from just, being derived from the sensational reports tourists and travelers are wont to season their writings with. The Indian cobra, or to give it full title, cobra de capello, or "hooded viper" (*Naja tripudens*), is far from being the vindictive reptile commonly depicted as perpetually lying in wait for an opportunity to carry death and terror to inoffensive humanity by means of its terrible fangs; but, on the contrary, it is a creature of nocturnal or crepuscular habits, during day lying coiled up and asleep in its lair, and at all times comparatively unobtrusive, and timid even to cowardice. It is implacable only toward those creatures generally classed as vermin, and, like the majority of the serpent tribe, only too happy if permitted to escape the presence of man in the nearest retreat, and manifests neither hostility nor displeasure other than by means of a mere threatening hiss.

In Hindostan, where, perhaps, the reptile is most general in distribution, its presence is nothing like universal, being dependent upon topographical features suitable for sustenance and reproduction, and vagaries of climate, soil, latitude, etc. In many regions, Bengal especially, it is altogether wanting, or so rare as to elude observation, and it becomes possible to reside in for years in the Orient without once obtaining so much as a glimpse of the species, save, perhaps, in the hands of some native mountebank. Civilization is its greatest foe, and it retires gradually before European settlements and methods of cultivation. In certain districts where its presence is well established, it is so unobtrusive as to be practically unknown save for a brief season immediately succeeding the rains; and even in Bundelcund, in the neighborhood of Lulutipore and Jahanzi, where it is especially numerous, is regarded as a source of annoyance rather than danger, exciting none of the fear and horror that the mere empty title obtains among residents of more temperate climes. The Anglo-Bengalee holds it in supreme contempt, as a creature to be classed rather among scorpions, centipedes, and vermin, than the more dangerous *ferœ naturæ*, and loss of life, save perhaps as the result of some foolhardy prank or criminal exhibition is unknown. After many years' residence, Captain Parker Gillmore declared he "could never hear of a European being bitten!" Boots and gaiters are invariably worn by foreigners and better classes of natives, and are efficient safeguards; and even trousers are in a measure protective, absorbing the virus, and catching and tearing out the fangs. Beds and couches are always surrounded by nettings of gauze, and covered by canopies as a protection against certain insect pests, while the ravages of others and of moth and damp insure close fitting closets and chests constantly under inspection, offering no lurking or hiding places for danger.

With the decline of the sun in the evening, the cobra crawls forth from hiding in search of toads, frogs, lizards, and the lesser forms of vermin and reptile life that afford it sustenance. For the sake of rats and mice there harbored, and of which it appears inordinately fond, it haunts abandoned cane and paddy fields, deserted temples, dwellings, fortifications, and honeycombed ant hills, or second growth jungles, rubbish piles, and ruins; and it is sometimes led thereby to stables and inhabited bungalows, when, if opportunity offers, it takes up its abode in drains, old wells, burrows, defective foundations, and even the eaves, thatch, and garret. Natives, the priests more especially, encourage its presence as a means of ridding their abodes of superabundant vermin, enticing and retaining by means of frequent libations of milk regularly supplied. No native, moreover, will destroy a cobra save under compulsion, since it obtains a semi-sacred character as typical of the couch and guardian of the god Vishnu; and when compelled by it to mourn the decease of a friend, or even one of his immediate family, the poor Hindoo ventures on no greater retribution than the coaxing or forcing of the reptile into a jar, when it is transported to a distance and again given its liberty.

During the heated term, in the low lands, when doors and windows are required to be perpetually ajar to insure necessary circulation and supply of oxygen, a reptile will occasionally venture into an apartment after nightfall, when all is quiet, traversing it about by following the angles formed by floor and wall; but as it vanishes with the dawn, its presence is seldom suspected or made known, except perchance it casts a portion of its slough during its peregrinations. A friend who established himself for a few weeks in an abandoned and dilapidated bungalow, because of its contiguity to certain shooting grounds, assured me that he twice found in his sleeping apartment the cast sloughs of cobras prowling over night; was once awakened by the fall of a cobra from the shaky ceiling, along with a rat it sought to make its victim, both striking the canopy of his bed and rebounding to the floor; and on a third occasion, on rising, chancing to kick over a shooting boot that stood in his way, much to his surprise a reptile that had chosen it as a convenient retreat crawled forth and made for the open door —"Not a pleasant companion for one's foot, surely," he remarked, "but no more than might have been expected in taking up such quarters in such a neighborhood without thorough inspection and overhauling."

That the loss of life among the native population, from cobra poisoning, is considerable, is a natural result of prevailing habits of life; and occasionally the annual mortality statistics are positively appalling. It is only the better classes that habitually clothe the extremities and use the charpoy, or native bedstead, the great mass of humanity pursuing their vocations and moving about bare legged and with naked feet, marching even through dense jungles and traversing deserted plantations and ruins with the utmost *insouciance;* and at night they cast themselves indifferently on the bare floor or naked earth with but a brief cotton garment wrapped about the head and upper portion of the body. A cobra prowling for prey will sometimes cross the body or legs of one thus disposed, who, half awakened by the weight and movement, puts forth his hand to discover that which disturbs his slumbers, touches the hideous intruder, who mistakes the act for one of enmity, and is immediately fatally bitten. The callous carelessnes of these people is astounding, and verges on absolute criminality; and how far it may arise from the sacred character with which the Hindoo invests the reptile, or from that universal fatality that pervades all classes, Hindoos, Mohammedans, and Parsees alike, I leave for others to determine.

Given one cobra in a neighborhood, and a second is invariably close at hand, presumably of the opposite sex, since Pliny remarks the affection of the male and female asp—Cleopatrine or Egyptian cobra (*Naja haja*)—asserting them to be constantly associated together, and that one invariably attempts to revenge the death of the other. The Cinghalese possess a kindred article of faith, saying that on the spot where one is destroyed, a second will be found soon after; and Sir J. Emmerson Tennent in a measure verifies this in several experiences. Once when a cobra was killed in a bath at the Government House at Colombo, Ceylon, its mate was found in the same spot the following day; again, at his own stables, a serpent having fallen into a well that was too deep to permit its escape, its companion, of the same size, was discovered in an adjoining drain. "On this occasion," says Tennent, "the snake, which had been several hours in the water, swam with ease, rearing its head and hood above the surface; and instances have repeatedly occurred of the cobra voluntarily taking considerable excursions by sea."

(This last statement must be received with caution, as it is based solely on native testimony, and hence is unreliable; undoubtedly, the *Pelamys bicolor* was mistaken for the *Naja.*)

When quiescent and unmenaced by danger, the reptile exhibits none of the peculiarities that authors in general are wont to depict for the horrification of their readers; and few travelers and tourists, presumably, ever see a cobra in unaffected repose, but only in the artificial character induced by the juggler. Instead of the large, full-hooded, and oval-flattened neck, overshadowing the head and considerably exceeding the body in diameter, it presents the same prone form, rounded contour, and tapering outlines of ophidians in general, except, perhaps, that the tail terminates more abruptly, and the body is more robust in proportion to its length, and its movements are in the main characterized by deliberation and sluggishness. It is only when excited and enraged that it rears its crest aloft for nearly half the length of its body, swaying rhythmically to and fro with the rigidity of an iron bar, head bent, deadly fangs erected, and tongue rapidly protruded and withdrawn, and air sibilant with its strident hissing; and it is now only that the neck assumes its hooded aspect, by drawing forward and expanding the first nine pairs of ribs, that are of a "floating" character, bringing into prominence in a most marked degree the two circular and connected spots of white that have given rise to the pseudonym of "spectacle snake;" and this act seems to be coincident with the erection and protrusion of the canine teeth that constitute the fangs. A serpent of five feet will erect its head for half a yard, or perhaps two-fifths its length, above the ground, drawing the posterior portion of the body into a coil, forming a virtual spiral spring, whereby it is enabled to pivot in all directions, and launch itself forward with incredible velocity and force for nearly its full extent; and it may even leap a yard or more when occasion demands, though in general is very chary of such efforts, seemingly aware that the momentary gain is an advantage lost in the time required to escape the prone form and again assume the offensive.

In spite of its venomous character, its natural docility and gentleness, coupled with its striking appearance, have made it a favorite with Oriental jugglers, the more so since the fatality that attends its wounds causes any trifling to appear the more wonderful. It is only fear that impels the cobra to strike, though this is far from being the generally received opinion. Popular belief, outside of India, credits performing serpents with the loss of their fangs, and their exhibition with being but one of their highly trained condition; but while this may be true in occasional instances, it is by no means a universal fact. The Hindoo understands full well the incredulity of all foreign Sahibs, the Anglo-Saxons in particular, whose commendation he is especially anxious to

secure, inasmuch as it brings him rupees where otherwise he would be forced to put up with annas; and he is therefore wont to exhibit the reptile's fangs *in situ*, and cause it to strike some small creature, as a bird or fowl, as evidence of its virility.

The handling of a cobra that has been rendered innocuous is barely worth witnessing, as it is a performance invariably of the most careless, inattentive, slipshod character; the juggler, unless a novice, wastes no arts upon such a reptile, and exhibits merely for the delectation of the ignorant and simple, or a species of advertisement to insure the relaxation of the purse strings of his audience later on. A few extra coins will always call forth the "simon pure," when his whole demeanor undergoes instantaneous transformation. He is no longer inconsiderate, careless, and indifferent, but his acts are marked by constant and rapt attention, swift and sudden seizures, and lightning-like releases, devoid of the least faltering or hesitation, every movement being a miracle of rapidity, certainty, and calculation, with a view of avoiding any rebellious or untoward attempt on the part of the reptile; and in this may be witnessed an exhibition of courage, adroitness, and daring of unexampled character. Provoking the creature to strike, he receives the blow upon the elbow of his left arm, previously well swathed in cloth; or he merely tempts it with a feint, when, ere it can again recover, it is seized by the right hand just below the jaws, rendering it instantly powerless; and when it is again released, it is by an instantaneous unclosing of the fingers and removal of hand and arm in a swift and dexterous upward swing that appears, as it virtually is, but a single movement. In time the viper becomes familiar with the acts, and learns that the handling and movements are in no way productive of injury, when it submits thereto unresistingly, and plays its part in mimic imitations of anger with spiral coil and expanded hood, and unless specially aroused becomes practically harmless. Nevertheless, there is always danger lest some unforeseen accident should provoke it to resort to its terrible weapons, when its blow is so swift and instantaneous that it often escapes notice for the moment, or until attention is called to it by the drops of blood that slowly trickle away from two needle-like punctures that mark the insertion of the fangs and inoculation of the venom. So rapid and fatal is the action of the poison, that few performers venture to ply their calling without a heavy, keen-edged knife at the girdle or concealed beneath the clothing, in order to insure safety by instantaneous amputation or excision of the bitten part. Sir Emmerson Tennent tells of a conjurer he saw bitten in the wrist dying the same evening, as the result of attempting some unusual familiarity, to which he was tempted by the plaudits of his audience; and Forbes, the author of "Oriental Memoirs," never doubting but that the serpent that danced before him for an hour on his table while he painted it had been deprived of its fangs, repeatedly lifted and handled to observe the peculiarities of coloring and delicate tracery of markings, especially the white connected spots that form the spectacles upon the hood; yet the following morning the same reptile, without appreciable cause, and while being exhibited in the Bazaar, darted at a native girl that was squatted near, inflicting a wound upon her neck from the effects of which she expired in less than half an hour.

Serpents are taught by their masters to coil and recoil, advance and retreat, bow their heads, approach their deadly mouths to their own, and perform various other antics and contortions in obedience to certain signs and sounds. This is the so called "snake charming," with whose descriptions we are wont to be regaled, though in reality there is nothing in the way of "charming" or of the oft heralded "musical performances." The sounds whereby the juggler controls his reptiles are exclusively monotonous buzzings and hummings, or shrill and earsplitting shrieks tortured from some reedy pipe, without either time or rhythm, and of a character that speaks little for veracity or for correctness of ear and knowledge of harmony on the part of those who offer such descriptions. The tales too that annually find place in the popular prints of the day of East Indians (invariably and most unaccountably residing in the *mountainous districts of Northern India*) who are forced to desert their homes and forego the pleasures of musical recreation because of the hordes of cobras attracted thereby, along with others wherein the extraordinary presence of mind in young gentlemen of the "griffin" persuasion saves lives by executing brilliant *fantasias* upon the flute at the critical moment the reptile is about to strike, are most mendacious and gratuitious inventions.

The great enemy of the cobra is the mongoose, a vivirine carnivorous quadruped of the civet family and genus *Herpestes* or "creepers," which provides something like twenty different forms or species. A trifle larger than a cat, it has the outlines of a marten, but with more pointed head, and exhibits various shades of coloring, coincident with surroundings and habitat, from a cinerous gray to ocherish yellow and dusky brown. Very partial to warmth, it thrives best in the tropics and subtropics of the Orient where it is native, but is sometimes found at heights of seven thousand feet or more above the sea-level; and it has recently been successfully introduced into the West Indies, and experiments looking to its acclimation in Australia are in progress. British India alone claims eight distinct species, of which the gray and yellowish forms *Herpestes fasciatus* and *H. vitticollis* are most common, while the handsomest, smallest, and most rare is the ruddy mongoose (*Herpestes Smithii*). Africa also boasts half a dozen species, the Egyptian ichneumon, which also bears the vulgar designation of "Pharaoh's rat," *Herpestes ichneumon*, or *Pharaoensis*) being best known. A very pretty form is found in Java, in the garaugan (*Herpestes Javanicus*); while Europe possesses a single specimen, the ichneumon of Andalusia (*Herpestes Widdingtonii*). All are marked by the same general characteristics and habits of life, and all are to a considerable extent fossorial, though taking readily to trees, especially in the presence of superior foes, climbing with no little address and agility.

The average mongoose is something like two feet in length from tip to tip, of which the tail claims at least one-half, with short and very stout legs, the forearm quite tapering, and each foot with five toes armed with long retractile claws. The head is small, handsome, and very ferret like, with piercing black eyes, short, rounded, mouse-like ears, and incisor and canine teeth of exceeding keenness; the tail is thick at the root, tapering, bushy, and supposed to afford mechanical aid in leaping and turning abruptly, as at such times it is brought with great violence to the ground, sometimes with such force as to cause bruising and bleeding. The claws serve no apparent purpose in securing prey, though they prove powerful weapons for tormenting, as it is wont to play with its victims when caught alive, as a cat does a mouse; the fingers are long, flexible, and wielded with all the adroitness of the raccoon, which creature it resembles in many ways, and they find constant use in dragging the eggs of birds and reptiles from their hiding places. Like the cobra, its sustenance is chiefly reptiles and vermin; and though it is an implacable foe to all serpents, it never seems to devour the poisonous varieties, though they are invariably destroyed when discovered. Under domestication, to which it is very susceptible, it is said to become savage when fed upon raw flesh, and that the sight of blood renders it frantic; but this I may be permitted to doubt, since all I have known were allowed the run of the house, and fed largely upon the rats and mice they killed. Ordinarily, carrion is rejected with disgust, but that this is not always the case I have the testimony of a gentleman, formerly resident of Hyderabad, who informed me that the last tiger kill his shikaree persuaded him to sit over in the night time, though literally putrid, attracted four or five of the little creatures, who "ate and fought and fought and ate, with their peculiar little squeals; and what struck me as peculiar was first the way they scattered when the tiger came on the scene, and secondly their devouring such a disgusting repast, which was little better than a moving mass of maggots; and that, too, in a jungle where there was living food in abundance."

Though possessing the glands peculiar to the family of which it is a member, the mongoose is entirely devoid of odor; and being moreover excessively neat in habits generally, and invaluable in eradicating pests in the way of reptiles, vermin, and larger insects, it is a prime favorite in Oriental households; its one unpleasant trait is a tendency to make a nasty mess when devouring rats, flinging bones and fur and bits of skin about with reckless contempt.

Nothing escapes its prying curiosity and inquisitive ways; and as it combines the litheness of the serpent with the stealthiness of a cat, intelligence of the dog, and cunning of a monkey, little escapes its jaws, and prey is secured in the most out of the way and seemingly inaccessible localities. The different forms and positions it imitates and assumes to deceive its quarry are beyond enumeration or comprehension, not the least remarkable of which is perching on its haunches and gathering the body together like a kangaroo, and then hurling itself to considerable distances with inconceivable rapidity, after the manner of that marsupial, by a series of noiseless bounds, the anterior extremities not once touching the ground. It swims and dives moderately, also, though vision appears to be restricted when beneath water; and while it enjoys that element for cleanly and recreative purposes, it never seeks food therein or assumes the other like habits with which it has been credited.

With unbounded curiosity, and restless ways that keep it continually a-foot, it is extremely impatient of confinement and prolonged caresses, though it frequently returns for attention or to rub against the legs of its master, and off again almost immediately, abundantly gratified; and strange to say, while as playful as a kitten, it exhibits few mischievous tendencies. It obeys the sound of the voice promptly, and with little or no training has been used to put up birds before the gun or bolt rabbits from their burrows, though it quickly tires of the amusement. Primarily it is somewhat inclined to querulousness, but this wears off as soon as perfect confidence is established between it and its master, his family, and the domestic animals. Of the attentions of strangers, however, it is very chary, and apt to resent the least familiarity with a bite. At the same time it will submit to untold teasing and rough usage from the person with whom it is on perfect terms of intimacy, without exhibiting the least resentment, and has been known to allow itself to be repeatedly seized by a Newfoundland dog and tossed into the air and again caught in its descent. In its incessant movement, it appears to be hunting, unless perhaps engaged in bestowing minute inspection upon some new and strange object; and it is a matter of some interest to observe its movements at such times, and the way in which it twists in every direction its exceedingly sensitive and mobile nose.

The senses, too, would seem most acute, since the presence of a strange person or animal is heralded, long before visible, by ruffled fur, arched back, and squealing barks, while the footsteps of master and friends are recognized with undisguised manifestations of pleasure before they are appreciable to human ears. If allowed, it will take up its quarters for the night beneath the pillow of its master, sleeping with its tail drawn over its face, but is ever alert and watchful, and anxious to investigate strange sounds and movements; but at feeding time it is wont to exhibit its carnivorous propensities in snapping, squealing, and biting at every one that approaches, even its best friends, though the demands of appetite once satisfied it quickly resumes its ordinarily pleasant demeanor. In one thing, if allowed the freedom of the house, it proves an inveterate nuisance, and no amount of training will correct it; it will sneak up to the table silently at meal times and pounce suddenly upon any article of food that seizes its fancy, even if on the fork in transit to the mouth, and then rush away with tail swelled and extended like a bottle brush, swearing vociferously to avert pursuit.

In its combats with the cobra, the mongoose depends solely upon its superior agility, and, in spite of assertions to the contrary, is as susceptible to the influence of venom as any other animal. One placed in confined quarters with a cobra manifested the strongest anxiety to escape, but, finding this impossible, turned to and killed his opponent, himself dying in little more than a quarter of an hour from the time he received the first wound; and though he was released immediately after the conflict, he made no attempt to pass the open door, evidently aware that his fate was sealed. The natives say that the intense rage with which the cobra inspires the mongoose makes him "sick" and "crazy," from which he does not recover until he has partaken of "medicine"—the root of the *Ophiorrhiza mongos;* and this appears to be the sole foundation for that remarkable tale so generally circulated, that the creature hies away after battle to seek an antidote for wounds. The root appears to be sought solely for the purpose that *Triticum repens*, quitch or dog-grass, is sought by canines—merely as an emetic.

Personally I have never been fortunate enough to witness one of these famous combats, and accordingly avail myself of the experience of Commander Beardslee, U.S.N., which he writes was had at the house of a Boston merchant in Singapore:

"One morning D. came into the possession of a fair sized cobra de capello, and at once cleared the hall for action, retaining some of the highest articles of furniture as reserved seats. The basket containing the reptile was placed on the floor, and by means of a cord capsized, thus releasing its occupant, which began sliding about, seeking an opportunity for escape. By intention, the mongoose was at the other end of the room, pursuing its customary investigations, but almost immediately perceived its foe, when it became momentarily rigid, then advanced slowly with arched back, gleaming eyes, and cat-like tread. Quicker than a flash, from trailing its yard of hideous gorgeousness upon the floor, the cobra sprang into an attitude for combat, and from a coil for base, reared its pointed head with expanded hood and eyes sparkling with rage, for nearly half its length above the floor; then, with fangs pointed toward its foe, tongue darting at intervals from its horrid mouth, and hissing with excitement, it stood prepared for the fray.

"The mongoose gradually approached until just beyond the striking distance of the serpent, paused a moment, then darted through the air like a shot from a gun. There was a momentary struggle, over almost before it began; the snake struck as the animal sprang, but its foe arrived in safety on the other side, while on the crest of the viper were two jagged wounds from whence the blood was trickling. Again and again was this repeated. By his judgment and agility the mongoose escaped a touch, while after each assault the serpent seemed to lose courage and strength, and new wounds were visible, until at last it no longer retained its erect and defiant posture, but, lying prone along the ground, sought only to avoid attack, but without avail. Steadfast and merciless, the little animal followed up his victory, and in a short time had nearly torn from its body the head of the unfortunate reptile, and death soon put an end to its struggles. The mongoose manifested no desire to devour his late antagonist, but sought to leave the apartment. D. called to it, but it would not obey, and seemed to be in an unnatural state of excitement, its eyes having a peculiar wild and greenish stare. He then attempted to pick it up, but, crazed, it turned upon him and buried its teeth in his hand. Dropping it, the door was opened and it ran out, disappearing for a day or two, when it again returned in its usual health and humor. My friend, however, did not fare so well. The little wound upon his hand rapidly assumed most alarming symptoms. The arm to the shoulder became swollen to twice its natural size, discolored spots made their appearance, high fever and other bodily derangements set in, and for many days his life hung in a trembling balance. All the symptoms caused by cobra poison, though not to the extreme degree, followed the bite of the mongoose, and I afterward learned that his health had been so shattered by his illness that he had been forced to leave the Indies."

With regard to the effect of the bite of the mongoose, which Mr. Beardslee appears to think arose from its teeth having come in contact with the cobra, or from cobra venom, he is undoubtedly in error, unless, which is highly improbable, the poison glands were accidentally encountered. It is a well understood fact among physiologists, that the saliva of any animal, even man (as well as some other secretions), undergoes a change under the stimulus of intense anger, and assumes a degree of activity that renders it highly poisonous; and this is the more apt to be the case in the tropics. The poison was that of the mongoose solely, the secretions of the mouth being affected by the highly enraged condition that is always induced by the presence of the cobra. As is known, any creature may partake of the poison of the most venomous serpent with impunity, since it is only when brought in direct contact with the circulation that it becomes at all dangerous.

Port Huron, Michigan.

CONSTRUCTION OF GLASS HOUSES.

THE more we see and hear on this subject, the more are we driven to the conclusion that the future glass roof will have to cover all in and leave neither woodwork nor putty exposed to the weather. In other words, glass roofs will be put together like slates upon the roof of a dwelling-house, or in some similar way. The only objection to this plan is that the rain would get in between the panes laid edge to edge flush, for there is no difficulty about the lap over at the tops of the panes. If any means could be devised by which the panes could be fixed together at the edges when laid flat, we should at once overcome the difficulty and do away with guts, astragals, putty, and all outside projections.

This is the point which horticultural builders have now to study. At present, in any attempts at covering in the framework of the roof with glass, the panes overlap both endways and sideways, hence allow much heat to escape at the numerous laps, and the wind also rushes in on windy days, keeping down temperature and entailing the use of more fuel.

The only modern houses I ever saw glassed in the way I have suggested, were exhibited by a French builder at the Paris Exhibition of 1878, and he got over the difficulty of the seams where the edges of the glass met by pasting over them narrow strips of tinfoil, which appeared very enduring and effectual, but did not look very neat. The roof had, however, a smooth appearance, was perfectly water-tight, and every portion of the woodwork was covered over, so that no painting of rafters nor anything else outside was needed.

Some builders have already got rid of outside putty, simply bedding the panes on a thin layer of putty laid on the rabbet beneath; but they still retain the wooden ridge between the panes, as well as the rafters. They only need now to go a step further and get rid of the last, making the panes meet over them, and the riddle will be solved.

The man who secures a patent for some design of this sort will probably succeed. It is what gardeners want. They have objections to wholly puttyless glazing because of the hard firing such roofs entail, losing in one way what is gained in another, especially in early forcing; cutting the panes wide and smoothly at their edges, and laying them close, edge to edge, on a bed of putty over all, one would think was not an impossible matter. If the panes could be fixed in position by a spring or copper nail, nothing more would be required, for in pressing down the glass upon the putty the latter would work up into any small spaces between and fill them up effectually. This is just what happens in glazing without outside putty. The panes are not cut particularly smooth at the edges, the putty works between them, and the wooden ridge of the astragal is skinned off by the knife afterward and is quite safe against drip. It takes little to hold a pane of glass in its place, and in a roof glazed in the way suggested there would really be no points for any force such as wind to lay hold of.

When I came here I found an old peach house glazed in this way that had stood for fifty or sixty years; but it was of homely construction and merely an experiment, the panes being old-fashioned and only about 3 inches long and 5 inches wide, fixed by copper tacks. The roof looked rather ragged, but it served its purpose, and during the whole time just named never needed to be painted outside. With panes 2 or 3 feet long, however, and from 1 foot to 2 feet broad, such a roof would be a very different affair.—*J. S. W., in The Garden.*

THE ARUM FAMILY.

A BETTER illustration of the water-loving character of the whole of the members of the Arum family could not well be given than that shown in the accompanying engravings, which represent two well-known plants growing under those conditions which Nature provides for them, and under which alone, imitated in our plant houses, can anything like success in their cultivation be achieved. Arums frequent only the moistest of situations, and whether found in the dense jungles of the western or eastern tropics or in the more temperate regions, they are always either luxuriating on the banks of a stream or under the shade of some forest in which moisture is abundant. The headquarters perhaps of the order is tropical America, especially the southern portion. Here Anthuriums, Philodendrons, Monsteras, and Caladiums, along with hosts of others, are found clinging around the limbs of the gigantic forest trees to whose shade they are indebted for protection from scorching sunlight, and under whose influence the air about them is kept ever humid and genial. Travelers tell us that in these forests the evaporation is as excessive as that of a vapor bath, and so it is in the Old World wherever the Arum family is represented—always excessive. Like ferns, Arums thrive best under extremely moist conditions. In the case of both there may be exceptions, but one cannot err in imitating Nature. No one could desire to have Spathiphyllum Dechardi better grown than we here see done by Nature herself. To neglect to supply it with an abundance of water is, so far as this plant and others of the same genus are concerned, almost sure to end in failure. The wretched condition of the Arum lily treated as a pot plant in the ordinary pot-bound manner, as compared with what it is when planted out and deluged with water, is another instance of the same sort of mismanagement. Anthurium Scherzerianum and A. Andreanum are almost semi-aquatic in their habits; and although the latter is found sometimes growing upon the trunks of trees, yet an abundance of rain and an atmosphere heavily laden with moisture supply it with those conditions with which it meets along the stream banks or in heavy marshes.

SPATHIPHYLLUM DECHARDI AT HOME.

The Spathiphyllums, including the species here represented, along with S. candidum, S. floribundum, and S. Patini, known in gardens as Anthuriums, are all natives of the humid forests of Columbia. Some good specimens of these, along with several others, are to be seen in the Aroid house and in the Palm house at Kew. The Caladiums, Alocacias, Colocasias, and Xanthosomas, all nearly related to each other both in affinity and appearance, are best planted out, or, if kept in pots, they must have a liberal amount of root room and abundance of water. The noble appearance of some of these plants when planted out has been well exemplified in the Palm house at Kew this year. There might have been seen Xanthosoma violacea, whose enormous leaves and violet-purple leaf-stalks are highly ornamental; X. robusta, with foliage 3 feet across and 6 feet in height; X. versicolor, Alocasia macrorhiza, whose stem is 6 inches in diameter and 6 feet high, and crowned with a head of large sagittate green leaves; A. zebrina, characterized by a leaf-stalk with a zebra-like variegation, and many others, all eminently adapted for large tropical stoves, in which they can be planted out.

The Amorphophallus and allied kinds are other noble members of the Arum family. Attention has already been directed to the fine appearance created by a bed of the A. campanulatus at Kew, and there are now in the Palm house several fine specimens of this plant, whose singular appearance, which may be likened to that of a gigantic vegetable umbrella, contrasts effectively with the plants among which it stands. The colossal member of this section of the order—viz., Conophallus Titanum—has not yet developed to its full dimensions under cultivation, but in time it is to be hoped it will reach its best in our tropical houses. In addition to the above, there still remain hosts of good garden plants among the Anthuriums, Aglaonemas, Dieffenbachias, Philodendrons, and Syngoniums, to which it will be well worth the while of those who have large tropical houses to fill to devote attention.

Calla æthiopica, Richardia, Arum lily, or lily of the Nile, by whichever name one cares to call it, is one of our everyday plants, grown by all and admired by all both for its handsome leaves and for its large white, sweet-smelling, trumpet-shaped flowers, so called, but I suppose every one knows that they are no more flowers than the sheath that envelops the wheat ear. The flowers are, however, inside that white trumpet, and it is to their distilling energy that the sweet odor emitted from the tube is due. Arum lilies are much used for the decoration of churches about Christmas time, and again at Easter they play a prominent part in the same kind of work. In order to have a good supply of the flowers of this plant, the following directions may be followed with advantage: Early in June the plants should be shaken out of their pots, cut up into as many pieces as possible, and planted in trenches prepared as for celery—that is, to three parts of loam add one part of fresh cow manure, and place a layer of it in the bottom of a trench about one foot deep. All through the summer an abundance of water should be given with a liberal addition of liquid manure as the plants advance in growth. About the end of September lift each plant with a good sized ball of earth attached to it and repot, placing them afterward in a shaded position in a cool house for a few days, so that no check may be experienced. When established they may be placed in a light, airy position in a greenhouse or frame, and as near the glass as possible. The temperature should not exceed 55°, a degree of warmth which will be sufficient to bring them into bloom by Christmas time and onward, until Easter. Resting or drying off for a time after flowering is not good treatment for these plants; they should be well supplied with water always. There is a variety of C. æthiopica known as C. hastata, distinguished by its yellow flowers. Both these plants are natives of the Cape, and not of the Nile region. It is strange that neither the lily of the Nile, nor the sacred lotus (Nelumbium speciosum), nor the sacred reed (Papyrus antiquorum) is now found wild in Egypt, nor do there appear to exist any proofs of their ever having been wild there other than the name, which stands for but little.—*The Garden.*

INTERESTING ROMAN DISCOVERIES.

SOME very interesting Roman sepulchral discoveries have been made lately at Mayence, in the carrying out of some considerable excavations and earth-works required for carrying the Ludwigsbahn Railroad around the city. Close to the Neuthor the workmen came upon a place of considerable extent, evidently assigned to the sepulture of civilians. A large number of large and small stone coffins were found at irregular distances from each other, the intervening spaces having been occupied by wooden coffins, as it proved by the fragments and the nails which were found. One stone coffin bore a plate, which seems to have previously served as the "head stone" of a former grave; and all the indications suggest that the place had been used at successive periods as a place of burial. Most of the graves that were opened contained skeletons of women and children, with which lay bracelets, rings, needles, censers for burning incense, etc. There was one metal coffin, in which lay a woman's skeleton, but without any inscription or ornament. In the children's graves there were toys and other objects, generally of beautiful workmanship, such as little bracelets, glass and earthenware utensils, etc. There was one little polished goblet of singular beauty. One stone coffin (the inscription on which contained some mistakes) held the body of a woman, dressed with lime for the purpose of preservation, having the back hair arranged in a long plait of eight strands, woven with great elegance, and the clearly discernible remains of a cap. The hair is now red, but most probably was once black. There was in the coffin a stone needle case, ornamented with gold bands, two bone dice, a wooden casket with bronze mountings, the key of which was in excellent preservation, and a bronze ring. As to other objects found in the place, a small bronze figure of a dancing Bacchante, three black earthenware water vials, beautifully painted, and bearing the following inscriptions, "Vivas mi," "Bibe," "Dos," were especially deserving of notice. A quantity of silver and bronze coins were found, ranging from the time of Hadrian to the end of the third century.

SOME PROPERTIES OF WATER*.

WILLIAM W. WILLIAMS, President Merrick Association of Engineers.

FIRST, it will be proper to consider what is water. Chemists tell us it is the result of the union of two gases known as hydrogen and oxygen in the proportions, by weight, one-ninth hydrogen and eight-ninths oxygen, and by measure, two of hydrogen and one of oxygen. The quantity of electricity required to decompose a single grain of water is estimated to be equal to a powerful flash of lightning. The enormous force necessary to tear these two elements from each other shows the wonderful strength of chemical attraction. We thus see that in a tiny drop of dew there slumbers the latent power of a thunderbolt.

In all probability, no subject has attracted the attention of the leading governments of the earth and their scientific men more than this well known fluid. Money and time without stint have been spent in researches on the subject. Pure water in nature does not exist; in the chemist's laboratory it is not always found. The rains from heaven are contaminated before they reach the earth, and this is particularly the case in and near large towns and cities. Look in what direction we will, we find that water is so bound up with our existence that without it there would be an impossibility of a possession. In the animal world the abundance of water very forcibly attracts our attention. It constitutes four-fifths of our flesh and blood. Man has been rather facetiously described as twelve pounds of solid matter wet up in six pails of water. A few ounces of water causes the physical difference between the round, rosy face of sixteen and the wrinkled, withered features of threescore and ten. To supply the wants of the system each man requires three-fourths of a ton annually.

Passing to the lower order of animals, we find this liquid still more abundant. Sun-fishes are little more than organized water. Prof. Agassiz analyzed one found off the coast of Massachusetts which weighed thirty pounds, from which he obtained only half an ounce of dried flesh. Naturalists state that an entire order of animals is composed of only ten parts in 1,000 of solid matter.

If we turn to the vegetable world, a plant may grow in a soil containing no potash, but it will not grow where there is no water. In all vegetable growth, there will be found a large percentage of this necessary fluid. Remove it, and they are decomposed into some new compounds.

Water in the mineral world is abundant; it determines the form of crystallization of many minerals, and is chemically locked up in them, invisible to the eye, but there nevertheless. In the image which the Italian carries through our streets, there is a pound of water for every four pounds of plaster of Paris. One-third of the weight of the soil of our farms is in this same liquid. Each pound of strong nitric acid contains 2¼ ounces of water, which, if removed, would destroy the acid itself. Water is the best solvent known; there are few substances that it will not dissolve. Its capacity to do so is largely dependent on its temperature. As an example: Water at 60° F. will dissolve its own weight of Epsom salts; at 212° it will not do so; whereas common salt will require 2½ parts of water at 60°. It dissolves eagerly some bodies or substances, while others it takes up sparingly. Iodine and sulphur it will not dissolve at all.

I will relate, from a personal knowledge, with what avidity it dissolved some of the component parts of blast furnace cinder. Less than thirty miles from here is a spring of water in an old tan yard, which was in operation in the revolutionary days, and this water was excellent for the purpose. About thirty years ago, a steam grist mill was erected about a third of a mile from the spring, and its water was used to make steam to drive the mill engine. Its quality for this purpose was good, making but little boiler scale. Some time after the mill was in operation, an iron company, whose ground the water passed through, commenced to fill up the low ground with their cinder. By and by it reached the water's edge, and some rolled into it. Now I suppose the water was not over twenty minutes passing by and along the edge of this cinder pile, and it became the most wretched of waters for making steam. The boilers became coated with a scale of lime, iron, and apparently everything that was contained in the cinder pile. Soda, potatoes, oyster shells, bran, and many other things were put into the boilers, to try to counteract the baneful effects, but it was of little use.

As another illustration of its power as a solvent: Six of the Saratoga springs, Saratoga County, N. Y., in every gallon of 231 cubic inches contain respectively 644, 701, 888, 956, 991, and 1195 grains of different minerals in solution. In addition to these the water is charged to the extent of from 212 to 454 cubic inches of carbonic acid gas. The temperature of these springs ranges from 40° to 50°. Water will dissolve 700 times its volume of ammonical gas.

Water is used as the standard for comparative weights of solids and liquids. In this, governments are very explicit as to how many pounds their several units of measure shall weigh, stating plainly, in a manner not to be misunderstood, the position or altitude the temperature of the liquid and the height of the barometer as the conditions to be observed to ascertain the true weight of a given quantity of the liquid.

The United States standard of measure, as laid down by

* A paper read before the Merrick Association of Stationary Engineers of Philadelphia, Pennsylvania, by a member.

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the government, is a gallon whose capacity is 231 cubic inches, and it says, in a manner not to be misunderstood, or without equivocation, that this unit, when filled with distilled water at a temperature of 60° F. at the level of the sea, and the barometer at 30 inches, shall weigh 8·33111 pounds. If we compare this result by the unit of measure of Great Britain, viz., the imperial gallon of $277\frac{274}{1000}$ cubic inches with its weight as ten pounds, or the French liquid decaliter of 610·2705 cubic inches and weight 22·02314 pounds, converting the one into the other, we will find that the weight given for the United States lawful gallon of water is substantially correct. A cubic foot of water at 60° F., barometer at thirty inches, weighs 62·331893 pounds. At a temperature of 39·2° F., any unit of measure of it, for example a cubic foot, will weigh more than at any other temperature; it is then said to be at its greatest *density*, and the weight of a cubic foot of it is 62·388 pounds; at 32° it is 62·387 pounds; between 39·2° and 32° it steadily decreases in weight; and between 39·2° and 57° *it increases;* but above this point, for every additional degree of heat, *it increases in weight.* Any further decrease of heat when at 32° causes it to solidify and expand with a force computed at nearly 30,000 pounds per square inch; and in connection with this part of the subject it seems to have a strange property, viz., that before ice melts it expands again, and it is said that if a quantity of water be converted into ice, in a vessel strong enough to resist its expansive force, and this vessel be placed in a temperature above the freezing point, the ice will not melt, because of its inability to expand, a necessary condition *previous* to its change of state.

The weight of a cubic foot of ice is given at 58·7 lb.; its average specific gravity at 0·94—that is with water at 60°, barometer at 30 inches; their comparative weights are as 0·94 to 1.00. I have said *average* specific gravity, which implies that there may be conditions other than an average one. Such is the fact. Ice reaches its maximum volume at 24°. Ice and water are of equal density at the temperatures of 16°, 32°, and 48°. Ice generally floats in water, because the difference in temperature is less than 32°; but if ice of less than 16° is put into water of more than 48° it will sink, and in this it follows the same law as other solid substances, viz.: If a body which is lighter than water be thrown into it, it will finally settle with its center of gravity below the line of the water and a little above the center of buoyancy.

All bodies will float that will not displace a volume of water equal to their own bulk; but if the weight of the water displaced is less than the weight of the bulk of the object thrown into it, it will sink.

The weight of a cubic foot of water at 212° is 59·837 lb. Attempts have been made to ascertain the weight of water at higher temperatures, but with not much success. A few years ago the United States government sent some persons of scientific attainments, at the solicitation of some of the governments of Europe, to ascertain, if possible, the weight of some unit of this liquid at temperatures above the common boiling point. The undertaking was so beset with difficulties as to be insurmountable, and it was abandoned, so that no one can say positively what is the weight of any unit of water above 212°. It is true we have tables giving the weight of various temperatures above 212°; they are probably approximately correct—sufficiently so for ordinary practical purposes.

Water is almost non-compressible. Under a pressure of 15 pounds per square inch it is compressed to the extent of one fifty-millionth of its former bulk. Were it compressible to any considerable extent, it would be impossible to pump it to any height.

The following saturated solutions of the different substances give their boiling points or temperatures on ebullition, with corresponding temperatures of water in steam boilers under given pressures of steam as per gauge:

Washing soda, 220°—temperature of water in a steam boiler under 2 lb. pressure. 209°+.

Sal ammoniac, 238°—temperature of water in a steam boiler under 9 lb. pressure, 237°+.

Saltpeter, 240°—temperature of water in a steam boiler under 10 lb. pressure, 240°.

Common salt, 227°—temperature of water in a steam boiler under 5 lb. pressure, 227°+.

Nitrate soda, 250°—temperature of water in a steam boiler under 15 lb. pressure, 250°+.

Pearl and carb. potash each, 275°—temperature of water in a steam boiler under 34 lb. pressure, 275°+.

Nitrate lime, 334°—temperature of water in a steam boiler under 56 lb, pressure, 303°+.

Chloride lime, 355°—temperature of water in a steam boiler under 129 lb. pressure, 355°.

These are given to show how difficult it is when water has absorbed or dissolved various substances to any extent, to overcome the cohesiveness of the particles.

The pressure of any liquid on the bottom of the vessel which contains it, is independent of the shape of the vessel. It depends on the depth of the liquid and the area of the bottom of the containing vessel; it equals the weight of a column whose base is the base of the vessel, and whose height is the depth of the vessel.

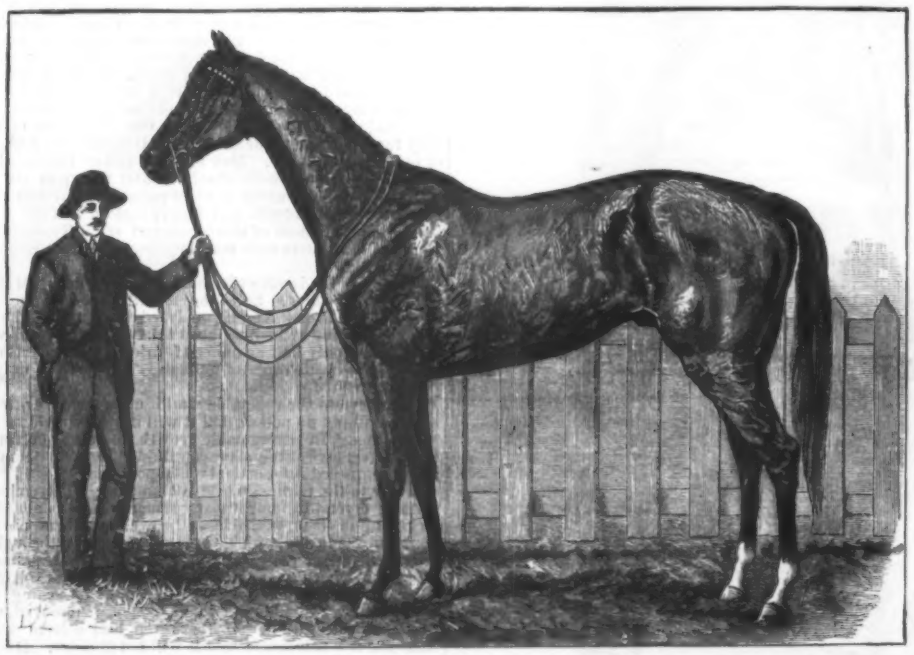
An interesting experiment to prove these statements can easily be made with the aid of a pair of counter scales such as grocers and others use. The customary accompanying weights are not absolutely necessary for the experiment; anything may be used in their place. Having procured the scales, also say a common glass tumbler, place the tumbler on the scales and balance it with anything at hand; now fill it with water and balance it in the same manner. Having done so, pour all the water out of the tumbler and replace it on the scales. Now prepare a plug—wood will do; let this plug's diameter be a little less than the inside diameter of the tumbler. Suspend the plug to something firmly and insert it into the tumbler, but do not let it touch it, either at the bottom or anywhere else; now fill the remaining space left in the tumbler with some of the water you poured out of it, being careful not to spill any on the scales, and when this space is filled you will discover that a tablespoonful or two has as much effect on the scales as it did when you had the tumbler full of water. In this experiment the area of the bottom of the tumbler remained the same in both instances. So did the height of the column of water. The plug in the tumbler had no influence whatever in the matter.

To ascertain the pressure per square inch on the bottom of any vessel, multiply the depth of the water in feet by the decimal 0·434.

The following is also given as the necessary height of a column of water to produce a pressure of 1 pound per square inch, viz., 2·311 feet, the temperature of the water to be 60° F. This is based on the following finding, that at the level of the sea the temperature of the atmosphere, 60° F., it will balance a column of mercury (60° F.) one square inch in area to the height of 30 inches. Now, a cubic foot of mercury at 60° weighs 0·491 lb. and we have 30 cubic inches in the column, which, if multiplied by the weight of a cubic inch of the mercury, gives 14·73 pounds as the weight of the atmosphere per square inch. Now the specific gravity of mercury at 60° F. is 13·58—that is to say, it is thirteen and fifty-eight one-hundredths times heavier than distilled water at 60°; consequently, if we multiply 13·58 by 30, the height of the column of mercury, we will have the height of a column of distilled water at 60 in inches that will balance the column of mercury, and this sum divided by 12 will give the height of the column of water in feet, which is 33·95 feet. Divide the number of feet found by 14·73 pounds, the height of the atmosphere as indicated by the column of mercury, it will give us 2·305 feet as the height of a column of distilled water at 60° to produce one pound pressure; but if we divide it by 14·7 pounds, which is called the average pressure of the atmosphere, it will give the figures first named, 2·311 feet; these are for columns of water at rest.

In the mechanic arts we are not likely to meet with sufficient distilled water for our operations—we have to take such as we can get—and should we undertake to produce given results by strictly adhering to the figures just given, we should be very apt to be disappointed. This is one of the places where theory and practice divide the honors. The case in this instance is obvious from what has been said of the constituents found in water as furnished us by nature; but nevertheless, theory, even here, helps us to find true results in practice. For a moving column of water to overcome an opposing pressure and frictional resistance through pipes and changing conditions of the atmosphere, such as the feeding of a steam boiler, it would be a perfectly safe rule to have a column as many times 2¼ feet high as there are pounds of pressure to be overcome.

MANY are the dangers that beset the sea-faring man, but the accident which lately occurred in New York Harbor adds another to the long list. It seems that a tug boat had been tied up at the pier and left in sole charge of the fireman. The latter, according to custom, turned on the water from the pier in order to fill the water tanks, but went to bed and fell asleep without shutting the water off. The consequence was that the boat filled and sank, the fireman barely escaping with his life.



THE AUSTRALIAN RACER MARTINI-HENRY, WINNER OF THE V.R.C. DERBY AND MELBOURNE CUP.

MARTINI-HENRY, THE AUSTRALIAN RACER.

No horse is now so well known by name as Martini-Henry, the double winner of the Derby and Cup, and his name is familiar as a household word all over the length and breadth of Australia. The horse was bred in New Zealand by the Auckland Stud Company, and is by the imported horse Musket out of the Australian bred mare Sylvia, who has given us winners while she remained in her native country. Martini-Henry is a beautiful blood like colt, standing about 15·3, and is so evenly put together that he looks fully an inch less. He is a fine mover when extended, and though an attempt has been made to decry Musket's stock as non-stayers, there can be no doubt about Martini's ability in this direction. He was purchased by Mr. White when eight months old for 1,250 guineas, and but for an accident would have run in the A.J.C. Derby. He made his first appearance in the V.R.C. Derby, which he won easily, and his victory in the Melbourne Cup was accomplished in even a more brilliant manner. His owner, Mr. White, is one of the pillars of the New South Wales turf, and it is satisfactory to note that a man whose name is synonymous with honesty should have been successful in the three great events of the V.R.C. spring meeting, he having won the Derby and Cup with Martini-Henry and the Maribyrnong plate with Iolanthe. Our sketch of Martini-Henry is taken from the life, and our artist has been very successful in reproducing his beautiful shape.—*Australian Illustrated News.*

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